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SEPTEMBER, 1953

Skyways

Flight Operations • Engineering • Management

COVER: Rockwell Mfg. Co. S-55 Helicopter

Jet Transport Outlook.....R. W. Rummel 11

Flt/Engr. Evaluation: Engine Analyzer.....Wesley Cook 12

Automatic Navigation Computers.....James L. Dennis 14

Ours is a Company 'Copter.....W. F. Rockwell, Jr. 17

Air Traffic Story:
No. 2: Common System..... 18

Flight Operations Round Table:
Present Use & Future Development of Helicopter..... 20

External Fuel Loading.....Harold Helbock 24

Skyways for Business..... 28

Now Hear This..... 7 **NBAA Report**..... 30

Performance Pitfalls.. 26 **Navicom** 33

Airport Service Guide..... 57

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Lockheed

C-130A Transport—
One Plane for 3 Jobs

Soon in production at Lockheed's Marietta, Georgia, plant, the U.S. Air Force's new turbo-prop transport, the Lockheed C-130A, will fly higher and faster than any other military transport and perform a great variety of missions.

The C-130A is the first transport specifically designed for turbo-prop engines, which harness jet power to propellers.

Air Force Competition Winner

Winner of an industry-wide Air Force design competition, the C-130A transport will perform three different jobs:

1. Carry soldiers, paratroops, patients and all types of ground force equipment up to items weighing twelve to twenty tons.
2. Fly high-altitude, high-speed missions as a tactical airplane for the Air Force.
3. Transport passengers on long-range flights for the Air Transport Command.

Unique Construction

The C-130A has a floor as strong as a concrete warehouse floor a foot thick. Its fuselage is only 45 inches off the ground—level with truck-bed height for easier loading and unloading. The pressurized cabin permits ground-level comfort for military personnel at high altitudes.

Of special importance to the Air Force, the new transport will require only short take-off and landing runs. Special tandem-wheel tricycle landing gear permits it to use emergency landing fields in forward areas, or even unfinished air strips.

Prototypes of the airplane are nearing completion at Lockheed's Burbank, Calif., plant. The plane will go into quantity production at Lockheed's Georgia Division, in Marietta, where giant B-47 jet bombers are currently being built.

...now hear this

PERSONNEL

Frank Pace, Jr., former Secretary of the Army and now executive vice president and a director of General Dynamics Corporation, and **Lawrence B. Richardson,** a senior vice president and also a director of General Dynamics, have been elected members of the Board of Directors of Consolidated Vultee Aircraft Corporation. **August C. Esenwein** has been elected a vice president of Convair and he will continue to be in charge of Convair's Fort Worth Division, **Charles F. Horne,** long-time naval officer, electronics expert and former Civil Aeronautics Administrator, has been named manager of Convair's Pomona, Cal., Division.

Robert A. Lovett, New York banker and former Secretary of Defense, was elected a director of North American Aviation, Inc.

Frank A. Heileman has joined the Board of Directors of Hiller Helicopters.

Stanley Gewirtz was recently appointed Assistant to the President, Admiral Land, of the Air Transport Association.

C. H. ("Dutch") Schildhauer, Capt., USN Ret., recently was appointed Assistant to the President, Wm. W. Brinckerhoff, of Air Carrier Service Corp.

Stanley C. Hellman has been named assistant director of Contract Administration for North American Aviation's Columbus, Ohio Division.

Walter N. Connors is Kellett Aircraft Corporation's new industrial relations administrator.

Harold W. Caward, a 13-year veteran of the airline industry, heads the newly appointed flight training staff of Western Air Lines.

John Hodgson, active in commercial aviation for the past 22 years, has been named assistant to D. R. Petty, vice president-flight operations for United Air Lines.

Fred Sansonetti has been made Assistant General Manager of Airborne Accessories Corp., Hillside, N.J.

John L. Higgins, former district sales manager, has been upped to Assistant General Sales Manager of Slick Airways.

COMPANIES

Delta-C&S Air Lines has purchased six additional Douglas DC-7 transports, bringing the total of the company's order to 10. First delivery is scheduled for early 1954.

Trans World Airlines had been awarded the 1953 National Safety Council award for providing nearly five billion passenger miles of completely safe travel. TWA was one of 42 scheduled airlines of the U. S. which completed 1952 without a passenger fatality and contributed to the best safety record for scheduled airlines in history.

United States Aviation Underwriters recently elected the following officers to its Board of Directors: Chairman—Reed M. Chambers; President—Albert J. Smith; Treasurer—Lillian Rogers; Vice Presidents—C. C. Compton, L. Wilkinson and W. J. Van Hoven; Assistant Secretary—Walter F. Peters; Assistant Treasurer—R. S. Brockway.

Seaboard & Western Airlines completed three years as a prime contractor to MATS on the Pacific Airlift on July 3. The trip on that day was Seaboard & Western's 2,145th Pacific crossing.

Douglas Aircraft has announced the DC-6C, a new model combining the special cargo facilities of the DC-6A *Liftmaster* with the passenger comfort features of the DC-6B airliner.

Grumman Aircraft Engineering Corporation has been elected to membership in the Aircraft Industries Association.

Bendix Radio Communications Division of the Bendix Aviation Corporation has received equipment orders amounting to approximately $750,000 from Consolidated Vultee Aircraft. Bulk of the new equipment is slated for installation in Convair 340's.

Six million dollars in new government business covering jet engines for guided missile application and internal combustion accessory powerplants for long-range bombers was announced recently by **Fairchild Engine and Airplane Corp.**

Western Air Lines has adopted the Avis Plane-Auto plan. Western is the 27th airline to adopt the **Avis Rent-A-Car System** in its fly and drive idea.

Westinghouse Electric Corp. and **Rolls-Royce, Ltd.** have signed an agreement providing for technical cooperation between the two companies for a period of 10 years.

The Arthur Godfrey Foundation has renewed its $12,000 annual Air Fellowship grant to The American University. This marks the third successive year of the grant and raises the total of Mr. Godfrey's support of AU's air transportation studies to $36,000.

CALENDAR OF AERO EVENTS

Aug. 19-21—Western Electronic Show & Convention, Civil Auditorium, San Francisco.
Aug. 25—Ninth legal committee meeting, ICAO, Rio de Janeiro.
Sept. 5-7—National Aircraft Show and 50th Anniversary of Powered Flight, Municipal Airport, Dayton, Ohio.
Sept. 7-13—SBAC Coronation Year flying display, Farnborough, Hampshire, England.
Sept. 7-17—Fourth International Aeronautical Conference. Joint meeting of RAeS and IAS, London.
Sept. 12-13—Third Wisconsin Air Pageant, Curtiss-Wright Airport, Milwaukee, Wis.
Sept. 21-25—National Instrument Exhibit, Instrument Society of America, Sherman Hotel, Chicago.
Sept. 23-24—1953 Meeting of Aircraft Spark Plug and Ignition Conference, Champion Spark Plug Co., Toledo, Ohio.
Sept. 28-30—National Electronics Conference and Annual Meeting. Hotel Sherman, Chicago.
Sept. 29-Oct. 3—National Aeronautics Meeting, Aircraft Engineering display and production forum, Society of Automotive Engineers, Hotel Statler, Los Angeles.
Oct. 10—England to Christchurch, New Zealand air race; speed and transport handicap sections.
Nov. 16-17—Aircraft Quality Control Conference, Biltmore Hotel, Dayton, Ohio.

Embry Riddle

and the University of Miami

announce two courses in preparation for executive aviation positions

The premium salaries paid aviation executives with collegiate educations prove the industry's urgent demand for top caliber management training. Realizing this need, Embry-Riddle in conjunction with the University of Miami is proud to announce a full 4-year degree course emphasizing aviation, as well as a 2-year certificate course which provides less academic study but a larger measure of technical training.

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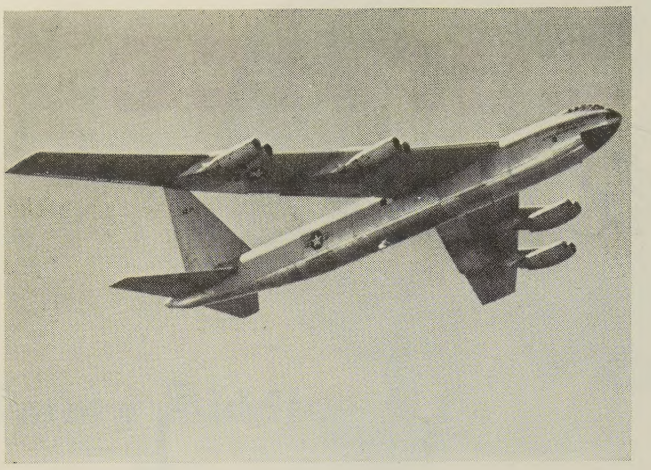
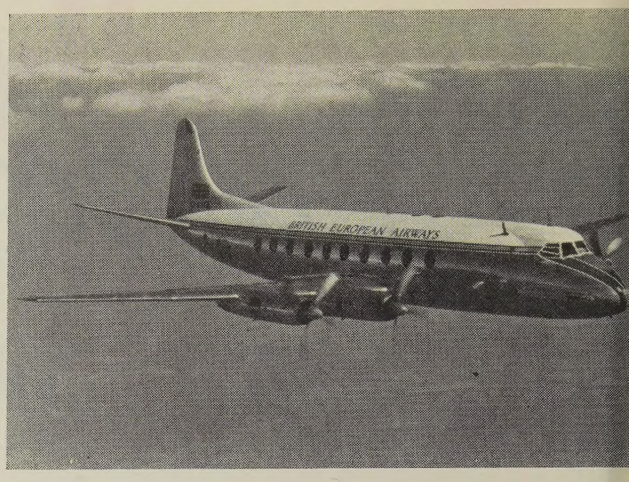
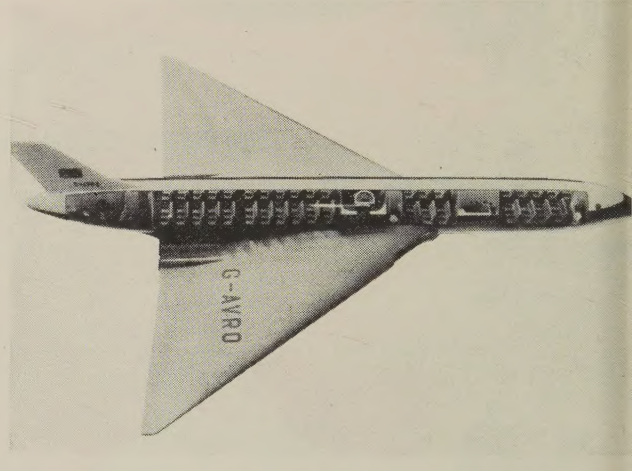


MILITARY *production of jet aircraft in United States, when compared to that of England, finds the U. S. in the lead. The eight-jet Boeing B-52 Stratofortress is being perfected after a most impressive development program*

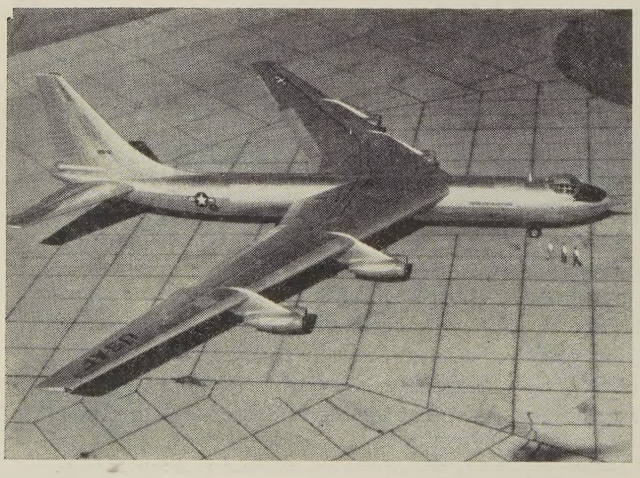


BRITISH *aircraft industry is leading the U. S. in the production of commercial jet transports. The turbo-prop powered Bristol Britannia, developed with support of state money, already has been delivered for airline use*

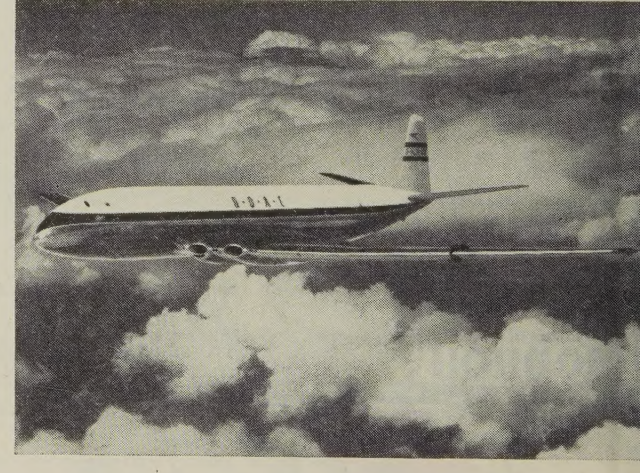
AIR FORCE *six-jet long-range Boeing B-47 bombers were being produced at the rate of one a day from one facility nearly a year ago. Today, however, B-47's are being produced for the Air Force at three separate facilities*



DELTA WING *jet airliner, first to be announced, is on drawing board in England. Developed from the Avro Vulcan delta bomber, the Atlantic has been designed to fly non-stop from London to New York in seven hours*



CONSOLIDATED *eight-jet B-60 bomber was built and flown in eight months. Converting heavy jet bomber-type aircraft into commercial transports is not considered practical due to the differences in operational requirements*



DH COMET *was in specifications stage in 1943. Now, 10 years later, 18 aircraft have been delivered for airline use. The Comet, Viscount and Britannia were developed with considerable support by state money*

U. S. experience in military jet production plus advancements in research indicate U. S. lead in over-all jet effort

JET TRANSPORT OUTLOOK

by R. W. Rummel,
Chief Engineer, TWA

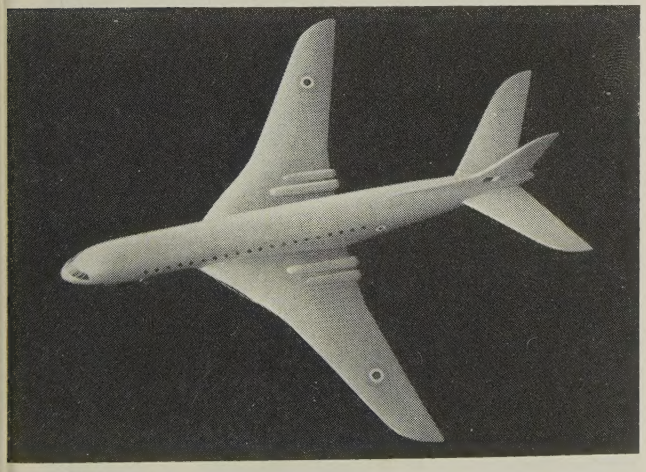
MUCH has been said about the technical and production lead the British have captured in the jet and turboprop commercial airplane field. This lead indisputably exists not only with respect to turbine transport-airplane production but also with respect to commercial jet-aircraft operations.

One question of immediate interest is whether this technical advantage will increase, decrease or remain static during the next seven years, for at the end of the seven-year period not only British but also American jets are almost certain to be flown by commercial airlines in fleet quantities.

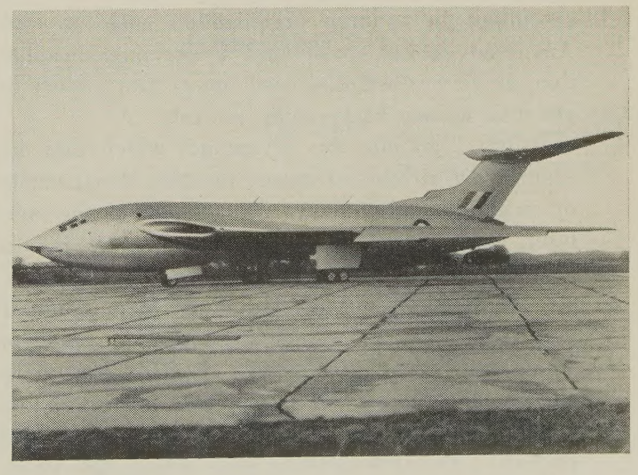
How will these future ships compare? Will they be economically equal or will one nation's aircraft show marked advantages over the other? Can America catch up or are we destined to a long term of lagging behind? While time alone can remove the speculative answers to questions of this type, study of the situation reveals trends which, if stable, seem to prophesy the final outcome. Trends can and are, however, frequently limited or markedly altered by changes in the political scene. For this primary reason, the author's effort to presage the jet's future is intended to indicate what can and seems *likely* to happen technically rather than what is unequivocally expected to transpire. With this in mind, the following offers answers to these and similar questions.

Before proceeding, it might be well to review the current British and American jet-transport developments and to mention a few of the future development possibilities.

In addition to the de Havilland *Comet*, the Vickers-Armstrongs *Viscount*, and the Bristol *Britannia*, the British probably will have at least two entirely new advanced jet transports in production by 1957 to 1960. These designs, the Vickers-Armstrongs commercial *Valiant*, and the de Havilland Mark IV *Comet*, will no doubt incorporate lessons learned from commercial operations with the Marks I, IA, II and III *Comets* and the early *Viscounts*, and both should be good airplanes. Along with other well-chosen criteria, these aircraft are being designed specifically to compete against future American jet transports. *(Continued on page 59)*



VICKERS ARMSTRONGS *has begun work on prototype military transport to be powered by four Rolls-Royce Conway bypass jet engines. Designated Vickers 1000, it has a wing pattern similar to that of Vickers Valiant bomber*



HANDLEY PAGE 80, *recently removed from Great Britain's secret list, is said to be world's first crescent-wing bomber. It is powered by four Sapphire engines. The HP 80 probably will not be available in quantity until late 1955*

Flight Engineer's Evaluation

ENGINE ANALYZER

Analyzer pinpoints trouble in flight; airlines' fleet installation shows great dollar savings per plane per year

by Wesley Cook *Flight Engineer, Pan American World Airways*
as told to Frank Harvey

Back in 1946, my employer, Pan American World Airways Inc., installed a bulky black box near my flight engineer's station aboard Lockheed *Constellation* N88868. They handed me a stack of weird-looking photographs which they called "trouble patterns." If the plane had electrical trouble, they said, any of these patterns might be expected to show up on the little three-inch scope of the black box. By matching the photographs with what I saw on the scope, I would be able to diagnose the trouble. I took the material, but not too seriously. We flight engineers see a lot of black boxes from time to time.

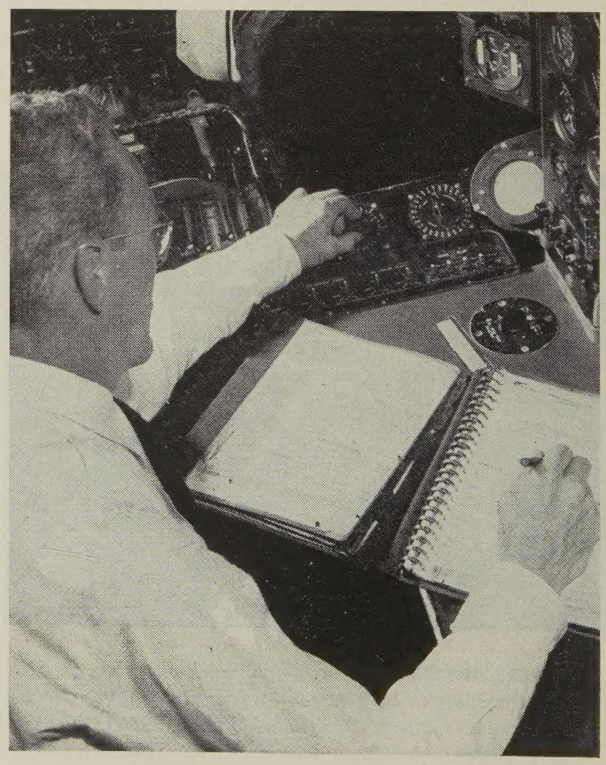
This particular black box, however, was destined to develop into a really useful tool. It is called the Sperry Engine Analyzer, and I have used it continuously for six years. I know it has saved the company hundreds of thousands of dollars. After being installed on *Constellation* N88868—the guinea pig ship—it was quickly placed on every *Constellation* in the Pan Am fleet, and in 1948, it was placed in all of our four-engined planes. Top executives in a large organization such as Pan American do not make such a sweeping installation, at very substantial cost, unless they expect to get their money back—with interest.

Before I go into the advantages which may be realized by airlines, company aviation departments or single executive planes through use of the analyzer, let me first briefly explain what it is. In simplest terms, it may be compared to a small TV set. It does not display Milton Berle or Dagmar on its scope, but it does display a jagged wave-form which comes from the plane's electrical system in action. As long as the system acts normally, this wave-form presents a steady, unvarying "normal pattern." But if something goes wrong, the wave-form changes to what we call a "trouble pattern."

This trouble pattern is, of course, the heart of the matter. Each electrical malfunction has its own individual trouble pattern—and each pattern differs from the other. You can, therefore, detect a fouled plug, mis-timed magneto, shorted or open secondary, breaker point bounce, no combustion and dozens of other troubles. Flight engineers add new "trouble patterns" to our log books every so often.

For example, coming into Berlin on a Pan American DC-6B a week or so ago, I noticed a strange fuzzy build-up on the pattern of one engine. It was something new, so I immediately made a num-

FLIGHT ENGINEER *is shown here operating the Sperry Engine Analyzer at his station aboard a Boeing 377. Note the scope on which normal or trouble patterns show up*



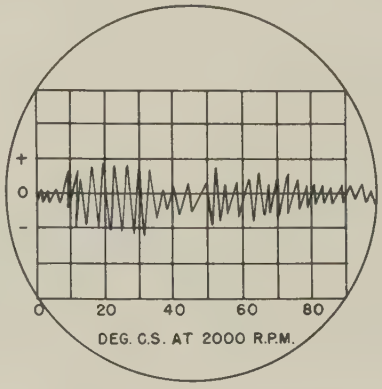
ber of checks, which are possible in the air, to see if I could further isolate the trouble and possibly correct it before we landed. None of my usual remedies worked, and there did not seem to be any serious manifestations of trouble, so I simply wrote up the phenomenon in my log, and drew my own "trouble pattern" for future reference.

Normally, after bringing a plane from the United States to Europe, we find ourselves taking a totally different plane back. In this particular instance, however, I happened to get the same DC-6B on the return trip, and sure enough, when I ran my analyzer check, there was the fuzz build-up. The ground maintenance crew had not remedied whatever was causing it. Thirty minutes out of Frankfurt on the way home, I suddenly lost the left mag on the affected engine. We made a turn around and landed again at Frankfurt, where we found that the low-tension lead had been broken off that particular magneto. This break was not a new one and it had been causing my fuzz build-up. Thus I had discovered a brand new "trouble pattern" which I have since been passing around to flight engineers of my acquaintance who may some day have to identify a broken low-tension lead. This is just one of hundreds of examples of how the analyzer grows in usefulness over the years.

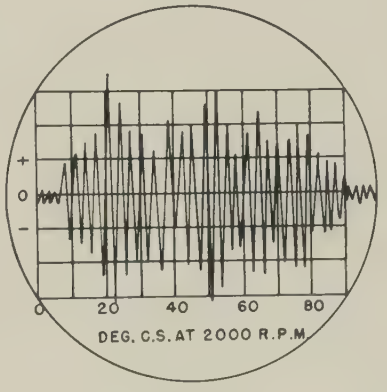
If anyone thinks that the engine analyzer is a tool one uses only in case of trouble, let me hasten to correct this thinking. The analyzer is used routinely, just like the various pressure gauges, temperature gauges, and other indicators on the engineer's flight panel. For example, I make a quick check on *all* plugs in all engines during the initial climb, when the engines are running close to full power. It is frequently true that troubles will show up at full power, during the climb, that are later hidden when the engines *(Continued on page 38)*

ENGINE ANALYZERS *installed on Pan American World Airways Constellations are estimated to have saved $9,000 per Constellation per year. Note position of scope on left*

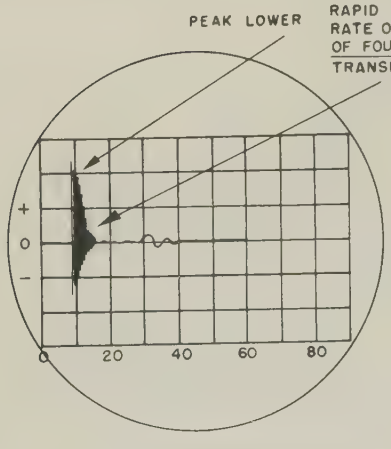
PATTERNS, *both normal and trouble, are illustrated here. New trouble patterns are added to Manual as they show up*



NORMAL COMBUSTION



DETONATION



FOULED SPARK PLUG

AUTOMATIC NAVIGATION COMPUTERS

by James L. Dennis
Wright Air Development Center

Air Force develops Type A-1 GPI and AN/APA-58 (XA-1) automatic dead reckoning computers for high-speed jet aircraft navigation

High-speed jet aircraft with fewer crew members have made critical the need for increased automaticity in as many navigation and flight control functions as possible. Very little time is available to the busy pilot-navigator of a jet fighter to manually compute dead-reckoning position and make plots of position and course on flight charts. Dead-reckoning position, as applied to air navigation, is a method for establishing the best estimate of aircraft position based on computation of the travel from a known position. Advancing the aircraft position from the known position to a later position is done by computing the travel along a ground track based on the ground speed and time of travel. Rather than require the pilot or navigator to solve this problem by the usual method of using certain manual analog computers, such as the E-6B, and by plotting on flight charts, Air Force contractors have developed computers which provide some automaticity to the solution of the problem.

In dead reckoning air navigation, the navigator customarily deals with the following terms *(see figure 1 below):*

Compass Heading (Hc)—The indicated heading of the aircraft with respect to the apparent magnetic pole, uncorrected for local aircraft distortion.

Magnetic Deviation (De)—Distortion of the earth's magnetic field by the aircraft structure. Varies with aircraft orientation.

Magnetic Heading (Hm)—The indicated direction of the aircraft heading with respect to the earth's apparent magnetic pole corrected for distortion of the magnetic field by aircraft structure.

Magnetic Variation (Var)—The angular difference between the apparent direction of the magnetic pole and true geographic north.

Wind Force (Vw)—Expressed in knots.

Wind Direction (Hw)—Expressed as a true direction from which the wind is blowing. Actually, in the A-1 Computer to be described, the wind direction is set-in as defined herein, but internally *Hw* is shifted 180°. In the other computer to be described, the AN/APA-58, wind is set-in or indicated in north-south and east-west components and represents the true components of wind velocity in those coordinates.

True Airspeed (Vt)—Early airspeed indicators gave readings which had to be corrected for tem-

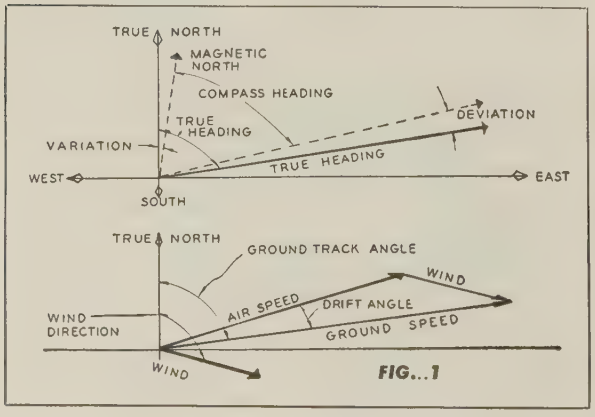
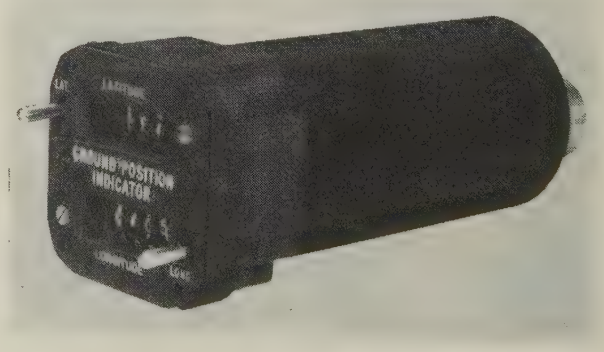


FIG...1

FIG. 2—*Indicator unit of the Type A-1 fits in standard mounting hole for three-inch indicator on a panel*



perature and altitude. Indicators are now available which make this correction internally, hence, are called True Airspeed Indicators.

Ground Speed (Vg)—The actual speed of the aircraft over the ground.

Drift Angle (D)—The angle between the true heading of the aircraft and the ground track.

Ground Track Angle (Hg)—The angle with respect to true north which represents the actual direction of travel of the aircraft over the earth.

The first computer to be described is designated as the Ground Position Indicator Type A-1, developed under contract with Ford Instrument Co. This computer indicates present position in latitude and longitude from continuous automatic inputs of true airspeed and magnetic heading, and from manually set values of wind direction, wind force, and magnetic variation. The latitude and longitude data can be reset at any time a dependable visual, radar, or celestial fix is obtained. The Type A-1 GPI consists of four units. *Figure 2* shows the Indicator Unit. Latitude and longitude counters can be reset by means of the slew switches. The indicator fits in the standard mounting hole for a three-inch indicator in an aircraft instrument panel and is eight inches deep. *Figure 3* shows the Preset Control Box which has the following dimensions: 5 3/4 x 3 3/8 x 5 3/8 inches. The computer unit is hermetically sealed and contains no vacuum tubes. It was designed to give many hours service without requiring maintenance. Dimensions are 8 3/4 x 6 13/32 x 9 13/32 inches. The Amplifier Unit measures 8 13/16 x 19 3/4 x 5 7/8 inches. Total weight of the computing system is 46 pounds.

In the A-1 computing system its inputs which are expected to be rapidly varying functions are automatic, whereas those inputs which are slowly varying (to an extent that only occasional reset is necessary) are manually introduced. That is, magnetic heading *(Hm)* and true airspeed *(Vt)* are automatic inputs, and magnetic variation *(Var)*, wind force *(Vw)* and wind direction *(Hw)* are manually set into the Preset Control Box. The problem to be solved is as follows:

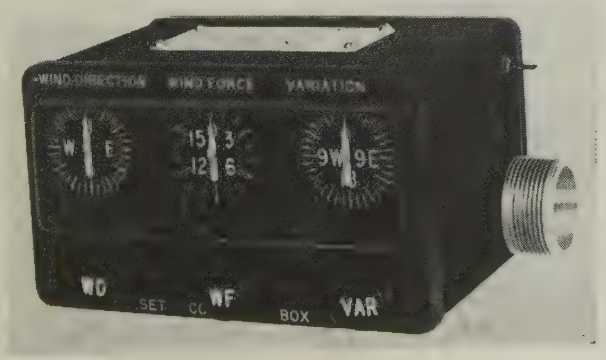
(1) Convert magnetic heading to true heading.
(2) Add vectorially the air velocity to the wind velocity.
(3) Resolve the resultant vector into longitude and latitude rates.

Figure 4 shows a functional diagram of the compass heading circuit. The indication of the compass *Hm* is transmitted by a synchro from the compass to a synchro control transformer.

Provision is made to correct the magnetic heading *(Hm)* for transmission error *(TE)*. The voltage corresponding to *Hm* is followed up by the synchro control transformer and the servo motor through the servo amplifier. The motor positions the transmission error compensator to an angle corresponding to the magnetic heading *Hm* plus *TE*. The output of the cam follower is proportional to *TE*, the transmission error for an individual installation of the equipment. This correction is mechanically added in the differential to the output of the servo motor. The sum of the two is fed back to the control transformer. The entire system is in balance and the motor stops turning when the differential output equals *Hm* and the servo output equals *Hm* plus *TE*.

Figure 4 also shows how magnetic variation is introduced. This is the other quantity necessary to complete the computation of true heading *(Ht)*. The variation control knob positions the rotor of a synchro differential in the Preset Control Box. In this mode of operation the output of the differential equals the input, and is received by a synchro transformer in the computer section. There the variation signal is followed up by the control transformer, amplifier and servo motor. The output of the servo motor is fed to one side of the differential. The other input to the differential is the quantity *Hm* plus *TE*, obtained from the servo loop just described. The output of this differential is, therefore, the true heading: $Ht=Hm+TE+Var$. *Ht* is used to position the rotor of an electric resolver which provides an input of *E sin Ht* to the longitude integrator and *E cos Ht* to the latitude integrator.

FIG. 3—*Preset Control Box of the A-1 is hermetically sealed and contains no vacuum tubes. Maintenance is low*



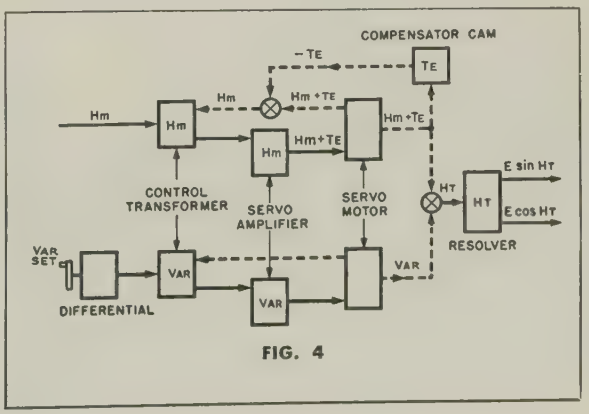


FIG. 4

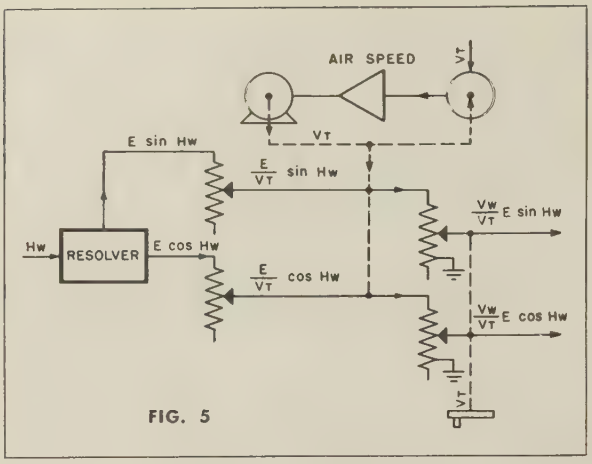


FIG. 5

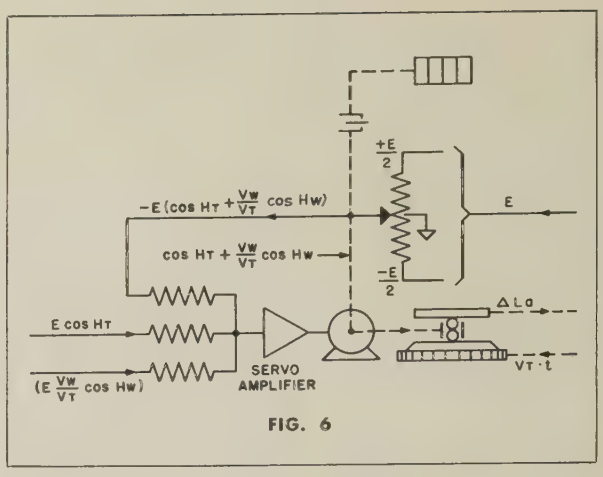


FIG. 6

In *Figure 5* is shown how the second of three voltage functions, which are the inputs to the integrators, are derived. The rotor of the wind resolver is positioned in accordance with *Hw*. Outputs are the usual sine and cosine functions. These are then divided by *Vt* in one set of potentiometers, the arm being positioned by the *Vt* servo. The resulting voltages are multiplied by *Vw* in a second set of potentiometers, the arm being positioned by manual set of wind force control, in order to obtain the functions $\frac{Vw}{Vt} E \sin Hw$ and $\frac{Vw}{Vt} E \cos Hw$.

Now we have as inputs through summing networks to the latitude integrator the following voltages:

$E \cos Ht + E\, Vw/Vt \cos Hw$

It should be noted that this is the north-south component of ground speed, divided by *Vt*. Clearly, if one multiplies the above expression by *Vt*, it becomes:

$E\, Vt \cos Ht + E\, Vw \cos Hw = E\, Vg \cos Hg$

However, the purpose of the division by *Vt* is to yield dimension less quantities and to produce a variable scale of computations which provides high accuracy at low values of *Vt*. The effect of this division is subsequently cancelled in the course of integration through multiplication by *Vt*.

The quantity $E \cos Ht + E\, Vw/Vt \cos Hw$ is transformed from voltages to equivalent shaft rotations by a servo-mechanism shown in *Figure 6*. The servo motor output is transformed into a voltage by the response potentiometer and this voltage is fed back to the summing network, thus completing the servo loop. Instead of being fed directly from the aircraft's power supply, the response potentiometer for the latitude integrator servo loop is excited by a resolver with a locked rotor. This resolver produces a response waveform identical to the waveforms of the outputs from the computing resolvers to yield optimum servo error discrimination in the summing networks and in the amplifier.

Also in *Figure 6* is shown how the output of the integrator servo is multiplied by *Vt* in order to cancel the earlier division by *Vt*. This is done by driving the disc of the mechanical ball and disc integrator by the function *(Vt. t)*.

In the A-1 GPI, the mechanical integrator carriage containing the ball is positioned by the velocity component. Since the disc is driven as a function of time, the integrator outputs from the roller are the time integrals of the velocity components.

One other problem eixsts. Since the linear distance between meridians of longitude decreases as the cosine of latitude, the change is longitude computed from the longitudinal ground velocity, *Vg sin Hg*, multiplied by the secant of latitude, *sec La*. *Sec La* is computed by inverting *cos La*. This inversion is produced by utilizing the inverting effect of the feedback loop in a servo-mechanism. For example, the typical transfer function for a servo-mechanism can be written as

$$\frac{O}{I} = \frac{1}{H}\left[\frac{GH}{1+GH}\right]$$

Where O is the transform of the output
I is the transform of the input
G is the forward gain
H is the transform of the feedback element

By compensating for the lack of infinite gain G, the feedback characteristic is effectively inverted by the servo-mechanism so that O equals $I\ (1/H)$. This property is used to invert *cos La* and to multiply *1/cos La* by the ground velocity *Vg sin Hg*.

The output from the ball and disc integrator is, therefore, longitude rate. That is, the roller will turn through an angle proportional to change in longitude. The same result is obtained in the latitude channel.

The second navigation computer to be described is the Ground Position Computer AN/APA-58(XA-1) *(Fig. 7, page 42)* developed under Air Force contract with Eclipse-Pioneer Division of Bendix Aviation. This computer provides es- *(Continued on page 42)*

ours is a COMPANY 'COPTER

by Willard F. Rockwell, Jr.
Pres., Rockwell Manufacturing Company

Routine day-to-day travel proves the helicopter to be Rockwell Manufacturing Company's best method of business transportation between home office, plants

Within certain specified limits, there seems to be a "best" method of transportation for every purpose. The search for that "best" method led us to a helicopter.

There is, of course, faster transportation than the helicopter, and also methods more economical. But just as the camel seems best adapted for the desert wayfarer and the air transport for long-distance flight, the helicopter seemed best suited for our particular problem which was, I now realize, somewhat more specialized than the usual corporate problem of providing efficient transportation for executives and staff members.

When we ordered an S-55 Sikorsky helicopter a year or so ago, we hardly *(Continued on page 46)*

ROCKWELL *president, W. F. Rockwell, Jr. (right) and K. W. Hutchins, head of Rockwell's industrial engineering department, are frequent travelers in the company 'copter*

SIKORSKY S-55 *takes off from parking lot at home office in Pittsburgh, flies direct to outlying plants and makes its landings just a few steps from the plant to be visited*

THE AIR TRAFFIC STORY

No. 2: Elements of the Common System
(Transition Period)

Second in a series of articles detailing Common System of Air Navigation, as told in "Air Traffic Story," by Radio Technical Commission for Aeronautics

The problems of air navigation center around instrument weather, when the pilot must guide his aircraft accurately in three dimensions, with nothing visible outside but cloud or fog.

In this "totally blind" condition, he must avoid collision with other aircraft or with mountains, radio towers, and other obstructions. He must fly accurately to his airport of destination. Finally, and perhaps most difficult of all, the pilot must leave the relative safety of higher altitudes and descend with precision to a pinpoint on the earth's surface—the landing field. All this must be done without being able to see either ground or sky and at speeds ranging upwards from 90 mph.

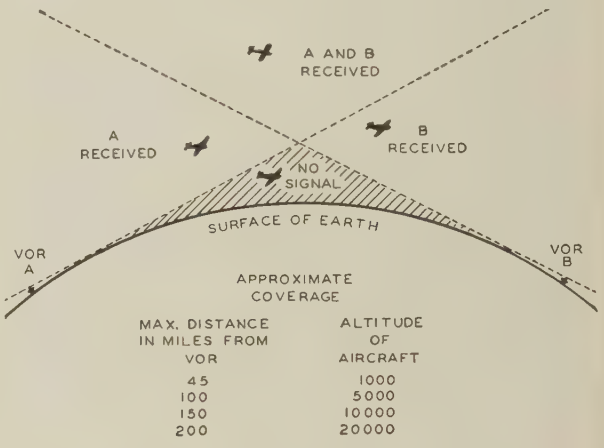
Radio aids to navigation made this kind of flying possible many years ago, and instrument flying has been successful for almost a generation. Many of the older aids to air navigation still are in use—in many instances they are operating side by side with newer and better devices. The older radio aids were, and still are, effective. But they are so awkward, so unreliable under certain atmospheric conditions, so unsuitable to large volumes of traffic, and so limited in their usefulness under extreme low-visibility conditions that they are inadequate for an all-weather system of air navigation.

LF/MF Four-Course Radio Range

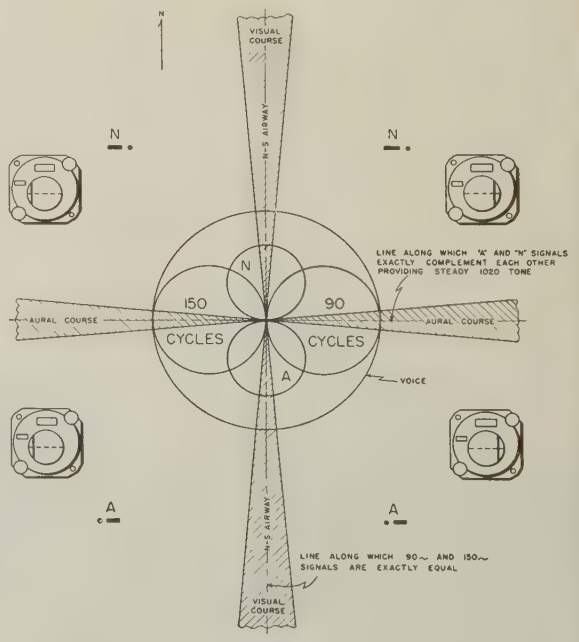
To understand how the newer methods of air navigation are used, and why they are necessary, it is best to examine the elements of the older system.

For enroute navigation—flying between cities along the airways—the LF/MF four-course radio range has been standard for more than 20 years. The installation on the ground includes transmitter equipment and five high antenna towers.

The ground station sends out four courses or radio beams, usually directed along an airway, although one course may point toward an airport 10 or 15 miles distant.



VOR *transmission characteristics are shown in this diagram (above) indicating the relationship between aircraft altitude and the usable distance of Very High Frequency signals*



DIAGRAM, *prepared by Bendix Radio, shows the field pattern of Visual-Aural VHF range. Note that combination of aural signal, indicator presentation is different for each quadrant*

The pilot, after consulting his charts, tunes in the range station on an ordinary radio receiver which covers the frequency band 200 to 400 kc—just below the broadcast band. If he is exactly on course, he will hear a steady tone, interrupted occasionally by Morse code identification letters. Also, from time to time, he will hear weather information and traffic control instructions transmitted from a CAA communications station associated with the radio range station.

If the pilot is "off the beam," he will hear either an "A" signal—a dot-dash, or an "N" signal—a dash-dot. This tells him he is one of the two "A" areas or two "N" areas associated with each range. To find out which of the four areas or quadrants he is in, if he does not know his position with respect to the station, he must fly a complicated and time-wasting orientation pattern.

As the pilot approaches one of the four courses, the "A" or "N" signal, as the case may be, will fade out gradually and be replaced by the steady tone. The pilot can keep to the right along on airway, as required by air traffic rules, by flying a course which keeps the tone steady with merely a faint trace of either the "A" or "N" signal, depending on the direction in which he is headed.

The LF/MF four-course radio range obviously gives the pilot definite guidance along the airway. But it has a number of very serious drawbacks and limitations. Among them:

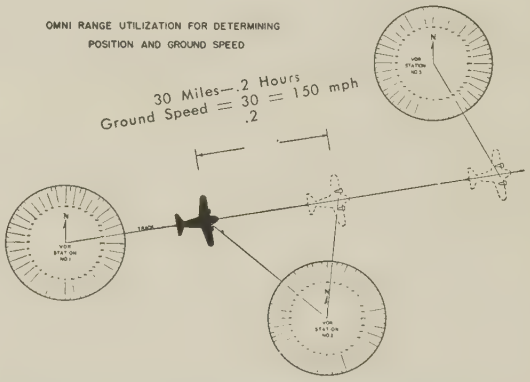
1. Because it operates on low and medium radio frequences, it is subject to static interference. Under thunderstorm and turbulent conditions—the very time it is needed most—the range signals may even be blanked out completely.
2. It is easy to confuse the four "A" and "N" quadrants and particularly difficult to determine which "A" and which "N" area is involved. A mistake in this procedure can have tragic results.
3. It provides only four narrow beams, giving no navigational guidance off the airways except the "A" or "N" signal. In congested areas, more than four aerial paths are needed to handle traffic efficiently—the inflexibility of the four rigid paths from a traffic control standpoint imposes a serious limitation on the movement of air traffic.
4. The width of the beam, and therefore of the airway guidance, is uncertain because it depends on the hearing acuity of the individual pilot, the amount of radio interference, and related factors.
5. Continuous listening to the range signals is a tiresome, monotonous chore. It can become exasperating when the signals are interspersed with painful bursts of static.

VHF Omnirange

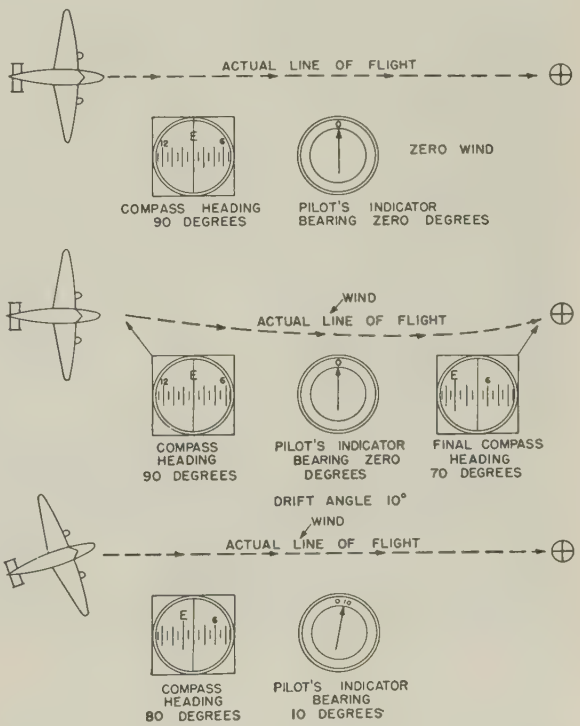
The modern counterpart of the LF/MF four-course radio range is the omnidirectional range or VHF Omnirange as it is commonly called. Often, it is referred to as VOR, which is an abbreviation of "Very High Frequency Omnidirectional Range."

The radiation from the VHF Omnirange is like a huge radio wheel, with the range station at the center and an infinite number of "spokes" radiating out from the hub. Each spoke, called an "omnibearing line" or "radial" in omnirange parlance, is a radio course which the pilot can fly.

The VOR transmitting equipment looks deceptively unimpressive, compared with the five high towers of the four-course range. It consists of a small rectangular building topped by what appears to be a white derby hat, *(Continued on page 48)*



METHOD *of determining position and ground speed, using two or more VHF omniranges, is shown in this diagram. Plotted on a chart, point of intersection of lines is plane's position*



EFFECT *of a crosswind on flight path and heading of an aircraft when an ADF is used for homing is shown in this diagram. Flying radio range is more efficient than homing*

Round Table Participants

CARL AGAR, Okanagan Helicopters, formed that company in 1946. In 1950 he was awarded Canada's top air award, Trans Canada McKee Trophy.

R. A. ASPINWALL, Asst. Gen. Mgr., Sikorsky, joined that Division of United Aircraft in 1943. Native of New York, R. A. Aspinwall is a graduate of Pace.

GLEN B. EASTBURN has been with N. Y. Airways since May, 1952. He was instrumental in establishment of helicopter mail service in Los Angeles area.

FRANK N. PIASECKI, Chairman of Board of Piasecki Helicopter Corp., developed his first helicopter in '43; pioneered the transport 'copter in 1945.

HARRY S. PACK, Vice Pres. of Piasecki Helicopter served as Mr. Piasecki's spokesman at end of meeting.

HARVEY GAYLORD joined Bell Aircraft in 1941; became Vice Pres.-Gen. Mgr. of Helicopter Div. in 1950. He is Past Chairman of Helicopter Council.

DONALD B. TALMAGE, Secretary of the ATA Committee on Helicopters, is graduate of Harvard. He joined ATA as Asst. Dir., Engineering Div. in '51.

ELMER E. "TUG" GUSTAFSON joined Sikorsky in 1951 after years in helicopter operations; was leader in developing use of 'copter in survey work.

STANLEY HILLER, JR., Pres. of Hiller Helicopters, developed and flew first jet torque compensating 'copter using simplified direct control rotor.

WARREN T. ROCKWELL of Hiller office represented Mr. Hiller whose arrival in Washington was delayed.

LESLIE O. BARNES, President of Allegheny Airlines, began airline work with American Airlines in 1937; was named Exec. Dir. of NATCO in 1952.

GLIDDEN DOMAN, Pres. of Doman Helicopters, organized his company in '45 after two years at Sikorsky. He developed new hingeless rotor system.

RICHARD K. WALDO, Chief Economist, CAA, is Chairman of Helicopter Working Group of ACC and is member of Convertiplane Group of ACC.

CHARLES H. KAMAN, Pres. of Kaman Aircraft, founded company in 1945. From 1940-45, he was Chief Aerodyn., Rotor Blade Div., Hamilton Standard.

JEAN H. DUBUQUE is Executive Director of National Business Aircraft Association, and a member of IAS.

HELICOPTER ROUND TABLE *participants (left to right around table) were Richard Waldo, CAA; Harvey Gaylord, Bell Aircraft; E. E. Gustafson and R. A. Aspinwall, Sikorsky; Carl Agar, Okanagan Helicopters Ltd.; Glen Eastburn. N. Y. Airways; Frank Piasecki of Piasecki Helicopter; Warren Rockwell, Hiller Helicopters; Glidden Doman of Doman Helicopters; Donald Talmage, ATA; Leslie Barnes, Allegheny Airlines; Fred M. Glass, Port of N. Y. Authority, who served as Chairman of the meeting; Bennett Horchler, SKYWAYS; Charles Kaman, Kaman Helicopters. Seated with back to camera (left) is Jean H. DuBuque, Executive Director of NBAA. Don Mockler, AIA, (upper right, wearing glasses) was a guest*

Present Use and Future Development of the Helicopter

Manufacturers indicate near-future availability of multi-engine helicopters to meet operators' needs

FRED M. GLASS, *who served as Chairman of Round Table, is Director of Aviation, Port of N. Y. Authority. Mr. Glass began his aviation career as Asst. Gen. Counsel of the CAB in 1938.*

Chairman Fred M. Glass *(Director of Aviation, Port of N. Y. Authority):* "Gentlemen, there are many phases of the helicopter industry which we could discuss here today. However, I suggest we confine our discussion to the commercial transportation phase. We have here an outstanding group of helicopter manufacturers, helicopter operators and those involved in the regulatory phases of helicopter operation, so I feel sure the subject can be fully and completely analyzed.

"As a background I would like to ask the helicopter operators just what they consider are the primary requirements the helicopter manufacturers must meet in order to provide the kind of helicopter that the local service carriers need. Mr. Eastburn of New York Airways, what are those prime needs?"

Glen B. Eastburn *(Ass't. to President, N. Y. Airways, Inc.):* "The primary problem we are now facing in our operations in New York is that of lift. In our development of routes up through Westchester County and in Connecticut, our mail load has increased tremendously. In fact, we are having to refuse mail at certain points because of having reached the capacity of the helicopter to handle it into New York. Part of that is due to an appreciation on the part of the mail user of the better service the 'copter has established, and the development of air freight. As you know, we are a common carrier and have tariffs for the handling of freight.

"Another problem has shown itself in our preparing the way for operation through New Jersey, and that is noise. The citizens of one area organized a protest against a proposed landing site as a result of the noise of our ship as it cruised around on a survey project. In our actual operations, however, we have had only two complaints and both of those were from the night shuttle. There hasn't been a complaint of any kind on our suburban operation.

"I feel that we should work toward making the helicopter powerplant quieter."

Local-Service Operator Requirements

Fred M. Glass: *"Do you consider the twin-engine helicopter a necessity in the type of operation you are now conducting?"*

Glen B. Eastburn: "Yes, because reserve power is essential in flying in a congested area, particularly as we look toward the development of passenger service."

Fred M. Glass: *"Mr. Barnes, as President of Alleghany Airlines, will you express the opinion of the local-service airlines with respect to the helicopter's potential as a replacement of the DC-3; and further state what operating and performance characteristics you think the helicopter will have to have before it can achieve that role?"*

Leslie O. Barnes *(Pres., Alleghany Airlines):* "I don't know that the helicopter or the rotary-wing type of aircraft will be the replacement for the DC-3. There may be an intermediate step. However, there is no question in my mind nor in the local-service carrier's mind but what the full potential of the local-service concept can be met with the rotary-wing type of aircraft. We'll progress along the road of ultimate development and ultimate utilization with the fixed-wing type aircraft, but we will not realize the full potential of the operation until we get into the rotary-wing type aircraft.

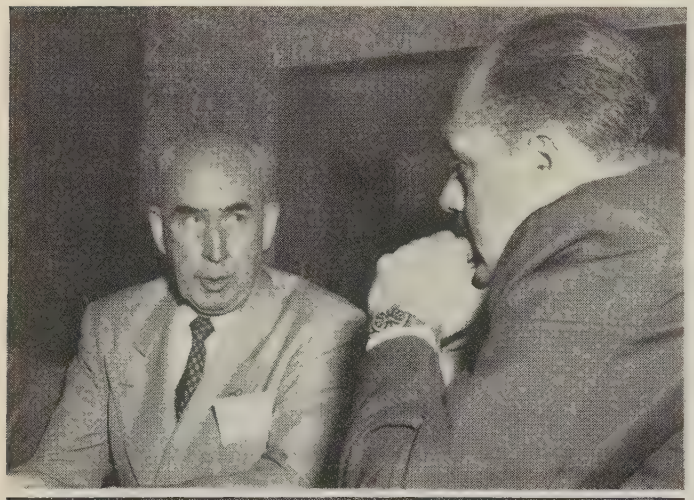
"Now, as to what is required, I believe that a number of things have to be met before we can get into the helicopter type of operations. Whoever ventures first into the field of helicopter operation without the strongest kind of support and financial backing is headed for trouble. Historically in this avia-

tion business, any time we get a new fixed-wing type aircraft, we've had a problem of shaking down, and some one carrier being the bellwether for a new type aircraft. Here we have an even more difficult proposition because we're not only changing the type of aircraft but we're becoming involved in a completely revolutionary concept.

"Mr. Eastburn has pointed up some of the operating problems. I think it must be obvious that the only way in which we are going to realize the full potential of the helicopter is to make our entry in this field with a minimum of 40 seats."

Fred M. Glass: "*What are the speed ranges and the passenger/mile costs that must be afforded in order for the helicopter to reach the place in the local-service field which you have been discussing?*"

Leslie O. Barnes: "A minimum of 150 mph is desirable, but not an absolute requisite. From my limited knowledge of the engineering aspects, the maximum we can get is probably 200 mph.



"**SPEED** *and range of the helicopter," said Mr. Eastburn of N.Y. Airways (top, left), directing his remarks to Mr. Piasecki (top, right), "is not as important to us as ability to get in and out of traffic generation centers." Mr. Waldo (above left, next to Mr. Gaylord) offered CAA help in transition from military to civil 'copter*

"As far as operating cost is concerned, there are two things that have to be considered. First of all, I think we'd be overly ambitious and optimistic to expect the helicopter to approach the operating cost of the fixed-wing type of airplane on a per passenger/mile basis at this time. That may come eventually and would be around 3 cents an available passenger mile."

Fred M. Glass: "*That's direct cost?*"

Leslie O. Barnes: "Yes."

Fred M. Glass: "*To summarize a bit, you consider that the helicopter for the local-service carrier must have single-engine performance, must be multi-engine, must have 40-passenger capacity, must have a minimum cruise of 150 mph, and must have an available passenger/mile direct cost in the neighborhood of 3 cents. Do I correctly understand your points?*"

Leslie O. Barnes: "I didn't exactly say that, but I agree with it."

Fred M. Glass: "*Mr. Eastburn, does that vary in any way with what you think the metropolitan type of operator should have?*"

Glen B. Eastburn: "N. Y. Airways is operating in a very densely populated area with traffic congestion, and we will accept and effectively and economically utilize a higher cost than was outlined by Mr. Barnes because we serve a premium traffic in mail and freight and, eventually, will serve passengers. In a relatively low-mileage operation, speed is not as important as the ability of the machine to get into and out of the center of traffic generation. To us that is vital and we've found that people are willing to pay for it. Mileage to us is not as important as the barriers over which we can move, and 10 miles in Metropolitan New York may be worth a hundred miles of cross-country operation.

Frank N. Piasecki *(Chairman of Board, Piasecki Helicopter Corp.):* "Have you determined what the upper limit of allowable cost would be for this operation?"

Glen B. Eastburn: "Traffic will bear a pretty high cost compared to fixed-wing operation because of the significance of the miles we fly."

Fred M. Glass: "*You're talking now of such type of operation as from the metropolitan area to an airport or between airports, a service that might be classified, to use a slang term, as a taxicab type?*"

Glen B. Eastburn: "Generally speaking, although our suburban operation extends out as much as 50 miles to Bridgeport and Trenton, for example. Actually, we have two types of operation, inter-city and inter-airport, and each has distinctly different problems. We are generating an increasing volume of carriage at a ton mile cost considerably higher than that of a fixed-wing operation. We carry the cargo and mail, and eventually will carry passengers, the final miles of a fixed-wing operation. We

are anxious to develop accessibility into population centers and the acceptability of our machine by the people . . . not only the users, but the public."

Leslie O. Barnes: "I'd like to ask a couple of questions, Mr. Eastburn. Do I gather correctly that for your type of operation you want a different type of helicopter for inter-airport operation than you want for inter-city work? The second question is, speed differs by how much? I said 150 mph minimum."

Glen B. Eastburn: "For the present, 85 to 90 mph. As far as our metropolitan operation is concerned, that speed is quite satisfactory. For the longer haul operation, 50 miles non-stop, a faster ship would cut down time. However, we can still show tremendous time savings with the present ship, the Sikorsky S-55."

Fred M. Glass: "*What would be the capacity of the helicopter you'd want for your type of traffic in the future?*"

Glen B. Eastburn: "I'd say about a 20-place. We believe that frequency is as important as capacity and speed."

Leslie O. Barnes: "Do you feel that in the ultimate pattern of things, we're going to have two different types of helicopter operations?"

Glen B. Eastburn: "If the helicopter lends itself to speeds up to 150 or 200 mph in larger ships, I'd say yes. For suburban and metropolitan operations, there is a different requirement; mainly for medium-sized or more versatile ships."

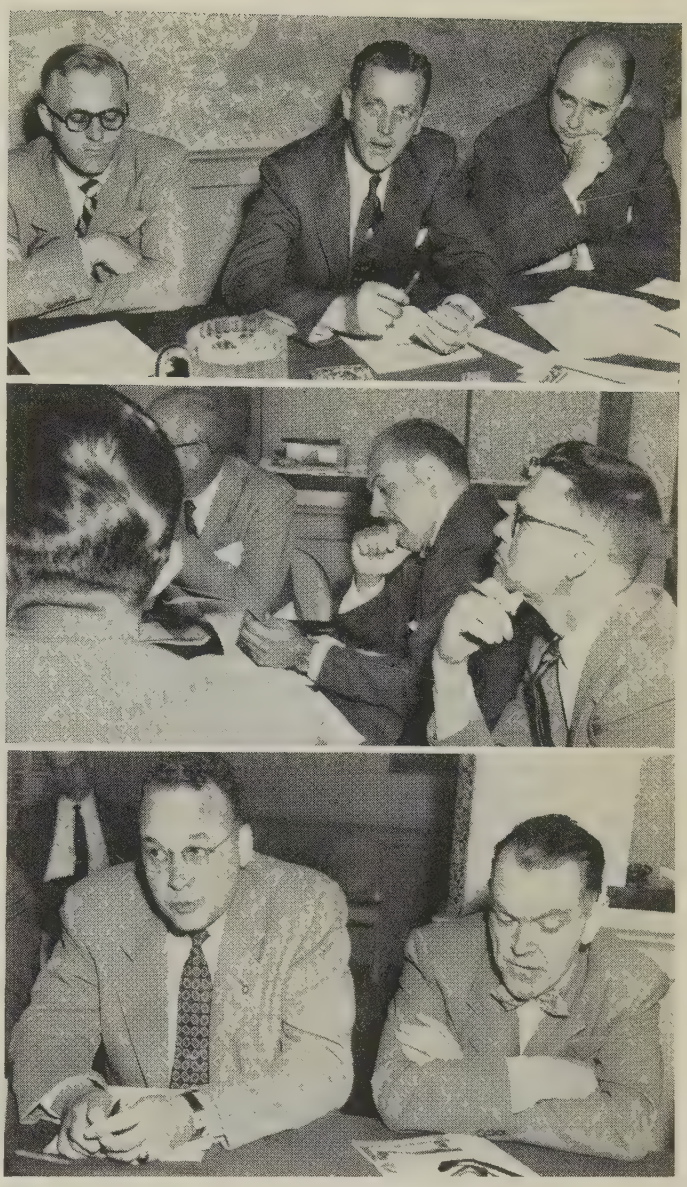
Fred M. Glass: "*Mr. Agar, your company has been using helicopters for activities that vary substantially from those described by Mr. Eastburn and Mr. Barnes. At the same time, your use indicates a rather substantial future market. Would you tell us something of your operations and what requirements you'd place before the manufacturers.*"

Carl Agar *(Vice Pres.-Operations, Okanagan Helicopter Ltd.):* "Before I go into that, let me say that I go along with both Mr. Eastburn and Mr. Barnes in their thinking as it applies to their respective operations—Mr. Eastburn's metropolitan, and Mr. Barnes' more inter-city type. The frequency of operation is more important than anything else with the helicopter, and it may be the factor that determines how big helicopters are going to be.

"Moving now into Okanagan's operation, we're primarily a bush operation. We carry both freight and personnel into mountainous regions.

"We're definitely looking to inter-city operations. There isn't much metropolitan-type of operation in Canada because there aren't many high-density areas. We, therefore, feel that the passenger business in Canada will initially stem from inter-city rather than metropolitan, and so we're looking for something to replace the DC-3.

"In the mountains we want a machine that has a margin of power. Whether we like it or not, for the next few years we're going to have to be satisfied with a helicopter that will take 1200 or 1300 pounds of payload. That figure has no significance as far as a variety of freight is concerned, but in our case we find that a lot of mining machinery that we could haul will break down into roughly 1200-pound loads. Therefore, we're interested in a helicopter that will meet that requirement. The small type of helicopter used today will handle loads up to 600 lbs. Single-engine will suffice for such operations in the bush." *(Continued on page 51)*



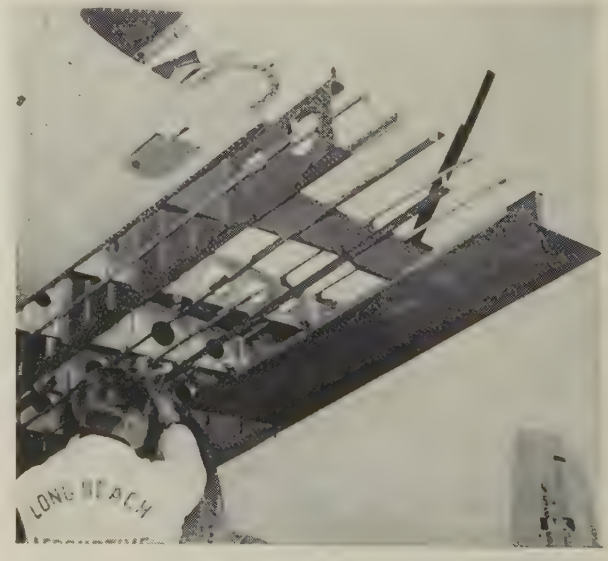
"OPERATING COST *of the helicopter must eventually reach a 3-cent-per-passenger-mile basis," reported Leslie Barnes (top photo, center, between ATA's Talmage and Moderator Fred Glass). Machines to meet operators' needs are under development for military and will soon be available for civil use, according to Mr. Piasecki and Mr. Rockwell (middle photo, right). "Depreciation cost is going to be commercial operator's big problem," reported R. A. Aspinwall (bottom photo, left, seated next to Carl Agar of Okanagan)*

External Fuel Loading

by Harold Helbock
Production Manager
Pastushin Aviation Corp.

WING-TIP TANKS *installed on B-25 (above) owned and operated by Schlumberger Well Surveying Corp. increased the business B-25's range to 3,450 miles. Tanks hold 197 gals.*

MINIMUM *of rework on B-25's wing was required for installation of modified Pastushin fuel tanks. Photo (below) shows tapered .032 24S-T doubler added to build up the shear area*



Everyone is familiar with the new businesslike silhouette of our combat planes—the sleek change in outline caused by external tanks. It is entirely possible that the new configuration, so well known in Korean skies, will become a more familiar sight at home.

External fuel tanks, commonly installed on military aircraft to increase combat range, may be used to advantage on both commercial and company aircraft. A significant milestone in the use of wing-tip fuel tanks on commercial aircraft is the installation of adapted Pastushin Aviation Corp. jettisonable fuel tanks for center-line mounting on an 11-place twin-engine executive airplane, a con-

Adaptation of wing-tip fuel tanks for business-aircraft use adds to safety. Tests also indicate tip tanks increase aileron effectiveness at slow speeds and offer better control during landing

verted World War II B-25, owned and operated by Schlumberger Well Surveying Corp., of Houston, Texas. Believed to be the first of its kind, the installation was designed and supervised by Aircraft Conversion Engineering Co., Glendale, Calif., and performed by Long Beach Aeromotive, Long Beach Municipal Airport, Calif.

Originally established in 1919 in Paris as a small consulting and research organization, the world-famed Schlumberger Well Surveying Corp. was formed in the U.S. in 1934. It provides technical services to drillers and oil producers in the U.S. and abroad. The airplane transports company personnel and cargo to distant job sites, conventions and company facilities in all parts of the world.

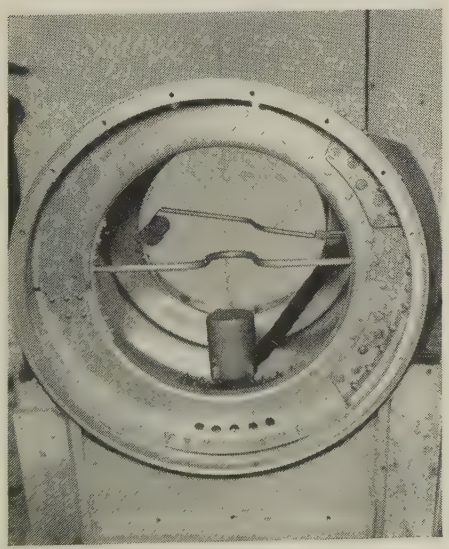
Design Problem

The decision to install wing tanks was made when the Schlumberger Corporation found it necessary to increase the range and seating capacity of the airplane, but did not care to introduce the hazard of having fuel tanks installed in the cabin area. In designing for passenger capacity to be increased from 6 to 11, Aircraft Conversion found that fuselage fuel tanks had to be removed to provide for the extra seating. Additionally, Schlumberger desired to maintain free access to the fuselage for the lengthy instruments used in the oil survey work which the aircraft was called upon to transport from time to time. The design problem facing the conversion company was how to provide for additional fuel capacity in less space than was previously available. To give the airplane the 3,450-mile range desired, it was decided to distribute 1,733 gallons of fuel between bomb-bay tanks to carry 365 gallons, internal tanks to carry 974 gallons, and external center-line mounted wing-tip tanks to carry 394 gallons.

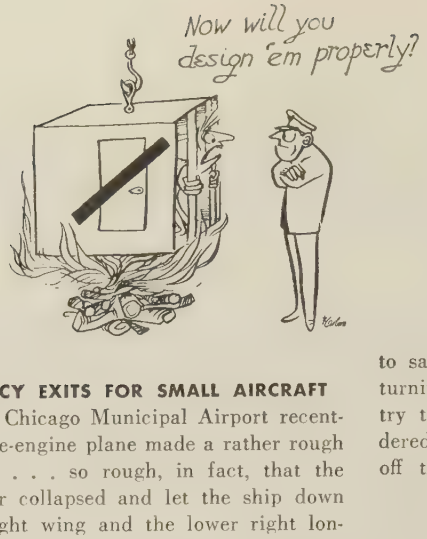
The center-line tip tanks of 197-gallon capacity were modified by Long Beach Aeromotive from 230-gallon jettisonable tanks manufactured by Pastushin Aviation Corporation for installation on the Republic F-84. Pastushin Aviation, a leader in the design and manufacture of jettisonable fuel tanks, produces external tanks for a variety of military aircraft including the F-86 *Sabre*, F-84, F-89, and other Air Force and Navy airplanes.

Prior to the start of the rework, Aircraft Conversion made extensive flutter and vibration calculations to determine possible critical frequencies. None was found and CAA approval was obtained for the basic design. This *(Continued on page 49)*

WIRES *for navigation lights in outboard side of each tank are conveyed to plane's electrical system through 52S-O tube through tank*



INSTALLATION *of modified wing-tip tanks on business B-25 was designed and supervised by Aircraft Conversion Engineering Co., performed by Long Beach Aeromotive. Each tank is attached by three close tolerance bolts*



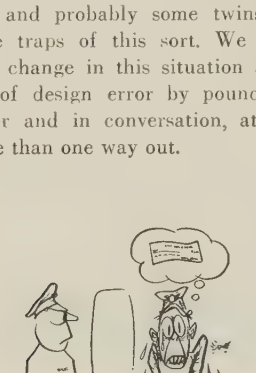
Performance

from the Files of the Flight Safety Foundati

EMERGENCY EXITS FOR SMALL AIRCRAFT

At the Chicago Municipal Airport recently a single-engine plane made a rather rough landing . . . . so rough, in fact, that the right gear collapsed and let the ship down on the right wing and the lower right longeron. The right wing was flapped back against the only exit, a door on the right-hand side, and the occupants of the plane were forced to remain inside until a wrecking crew could lift up the airplane so that the door could be opened.

This accident pointed out the importance of having an emergency exit on the opposite side. Had a fire enveloped the aircraft after the crash, the lack of an emergency exit would have been a grim reminder of inefficient design. There are other single-engine aircraft and probably some twins that are also fire traps of this sort. We can bring about a change in this situation and a correction of design error by pounding away, on paper and in conversation, at the need for more than one way out.

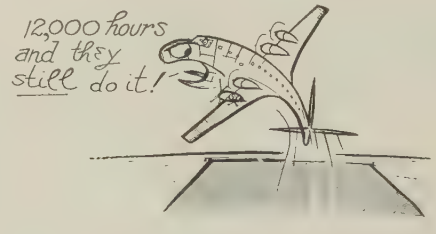


CHECK RIDES

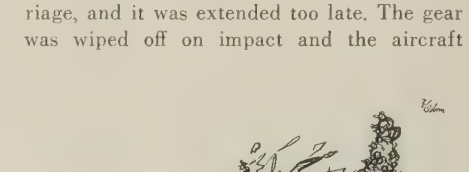
One important fault with check rides is that the pilot or crew being checked may become tense for fear that this may mean job trouble. Perhaps a better word ought to be used so that a pilot being checked won't get the idea it might mean his livelihood. It could be called "diagnosis," "standardization," "analysis," "rehearsal," "modernization," "bringing up-to-date" or some other such innocuous term that would free the crew from psychological pressure. Why not try it out . . . . and note better results?

EXPERIENCE VS. TRAINING AND CREW COORDINATION

A pilot with some 12,000 hours had an engine of his transport quit on take-off. Instead of climbing his heavily laden aircraft to safe altitude, dumping fuel and then returning, he did an immediate 180° turn to try to land on the take-off runway. He ordered all emergency exits open but turned off the seat-belt sign. The net result was



pretty chaotic. Many of the passengers ran to the back of the cabin for greater safety. The copilot failed to check the undercarriage, and it was extended too late. The gear was wiped off on impact and the aircraft



burned completely and quickly. Fortunately, however, there were no fatalities.

The whole deal indicated lack of training in emergency procedures and inadequate crew coordination . . . . which is gross understatement in this instance.

MORE ON FLAG ALARMS

Last month we listed several procedures to follow to compensate for inadequacies of some flag alarms, and we cautioned pilots about placing too much trust in those alarms. That caution is worth repeating, and here are some additional suggested procedures that are recommended:

ILS Operations:

1. Where dual localizer and glidesl systems are installed in the aircraft, set h systems to the ILS frequency prior to c pleting the final turn inbound on final proach.

2. Check localizer receiver audio for p er identification signals to make certain interfering signals are not present (igni noise or FM interference). If interfe signals are present, make sure they are down in the background before proceed beyond the outer marker inbound on final approach and then proceed with treme caution.

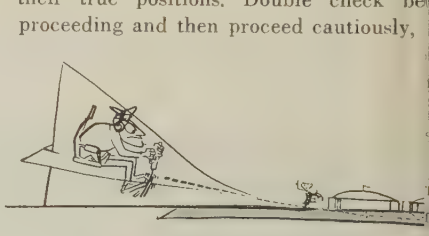
3. Check localizer alignment against A indications from a compass locator, prio reaching the outer marker on your final proach.

4. Get on the glide slope on course to or by the time the outer marker is reac so that the glideslope altitude at the can be checked for proper glideslope al ment.

5. Monitor the localizer voice channel radar advisories at all airports equip with Precision Approach Radar.

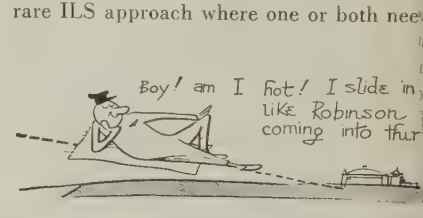
General Operations:

Always be alert to recognize sudden j deviation indicator movements as indicat of possible receiver failures which may displacing the on-course indications f their true positions. Double check be proceeding and then proceed cautiously,



ticularly when the sudden deviation-indic movements are of large magnitude.

Always be alert to recognize "dead" de tion-indicator needles. Remember, it i rare ILS approach where one or both nee



remain dead centered for more than a seconds at a time. If you feel you are ticularly "hot" on an approach, always

PITFALLS

y Jerome Lederer and Robert Osborn

nber the deviation-indicator circuit may open or shorted. In VOR operations, the iation indicator can always be checked a dead needle by turning the OBS.

he flag alarms do warn the pilot of the st frequent types of system failure. How-r, dual systems and proper checking and ss checking of single systems will warn the remaining system failures. Most im-tant is probably alertness . . . . be an alert ot and use your tools wisely.

EW PERFORMANCE—ICING

t may seem a little early to be talking ut icing conditions, but experience in-ates that not only is repetition good but we're given time to think on things, we do better job all the way around. SO . . . . e are some early comments on icing, and re will be more coming along from time time.

An air transport entered an overcast at 000 feet where light icing was indicated. de-icers and carburetor heat were ap-ed. A gradual loss of airspeed was not rrected by a descent to 16,000 feet and the of additional power. The course was ersed, with further descent to 15,000 feet, d application of METO power was re-ired to maintain an airspeed of 150 to 155 h. Although the wing and tail de-icer mperatures remained normal, the cabin-ater fuel pressure dropped to 10 pounds d smoke odors appeared in the cabin and kpit, presumably caused by icing of the in air intake. The cabin heaters were ned off and pressurization was partially eased. The captain's airspeed indicator gan a gradual increase and his altimeter dication remained at 14,000 feet, but the pilot's instruments showed 135 to 140 mph d 11,500 feet. The flight engineer noted is discrepancy but did not consider it cessary to mention it to the captain.

When the airplane shuddered under a rtial stall, the captain realized that his struments were incorrect and he applied ergency power of 50 inches manifold pressure and 2700 rpm for about 30 seconds. Shortly thereafter the aircraft broke out of the overcast, lost the ice, regained normal speed, and landed safely at origination point.

Reports indicated that wing ice was spotty and about six inches thick in places; the windshield was iced solid, the side windows were partly iced, and the top and bottom of the fuselage was heavily iced, as evidenced by pieces having dropped away after normal cruising speed was restored in clear, warmer air, at which time the captain's instrument readings operated normally again.

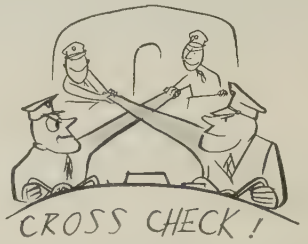
The copilot reported that upon occurrence of the partial stall he switched to his alternate static source and verified the correctness of his instruments. It was concluded that the extreme icing conditions encountered, with high liquid water content and large drop size at an outside temperature of 15°F, were responsible for ice formation far enough back on the fuselage to affect the performance of the instrument static system, causing the errors in the captain's instruments. Ice also partially blocked the airfoil scoops interfering sufficiently with the cabin airflow to cause the odors. There was no evidence of oil leakage through the supercharger seals into the airstream; no oil was found in the ducts and all duct joints were secure. Air-conditioning and de-icing system were found to be satisfactory.

Altitude is a Safety Cushion ▶ Hindsight forecasting indicates that in this particular case it would have been better to have gone through the area at 20,000 or 22,000 feet, which probably would have put the flight on top, judging from the experience of flights in the area somewhat later. Generally speaking, given the probability of moderate to heavy icing conditions, fly high rather than low, and this is particularly true of some off-course, off-airways routes over rugged terrain. You can always come down, but you can't always go up.

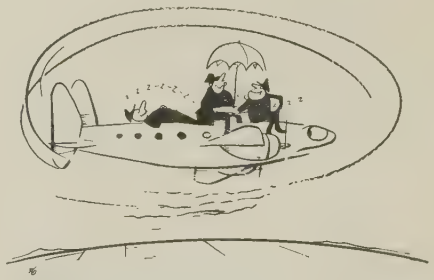
Use All Resources at Your Command ▶ The second point made is that of always using the alternate static source when in anything other than a light icing condition. This is particularly true when ice formation on the side windows of the cockpit warns that there is probably ice on the side of the fuselage, and that is where the static vents are located.

Think Ahead ▶ As a third point, remember the necessity of keeping the airspeed up before a point is reached at which the use of full power becomes necessary. If the airplane is taking on a lot of ice and an attempt is made, after a loss of airspeed, to maintain altitude and airspeed by pulling up the nose and applying power, the results are very likely to be bad.

Allow for Other Consequences ▶ In the case mentioned above, the cylinder head temperatures were rising rapidly due to excess power being used, and the cowl flaps were opened to a considerable degree, further increasing the aerodynamic drag on the airplane. Keep the nose down and the airplane "on the step."



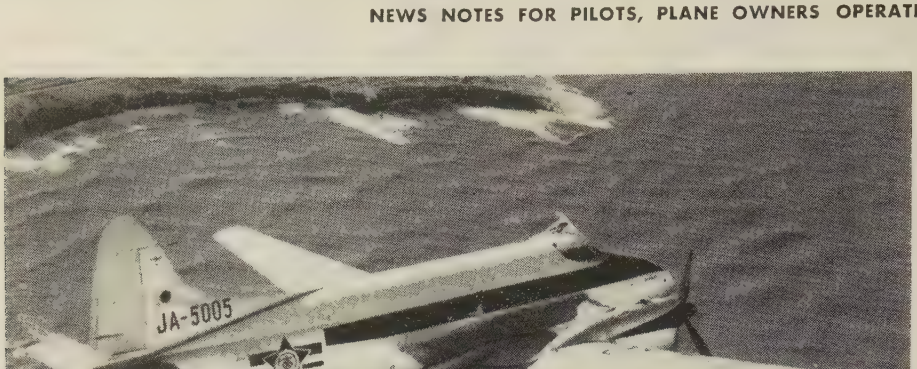
Insist on Continuous Cross-Checking ▶ The fourth point is one about which many captains have instructed their copilots and engineers, and which is sound practice. Whenever any one of the crew members notices something in the cockpit which to him is not quite right, he should in every instance bring this to the attention of the captain and he should not assume that the captain is aware of the irregularity.



WHERE WAS THE CREW

An airline pilot has reported several instances of flying off course when captains adjust the automatic pilot and inadvertently do not get the knob in the indent. As a result, the ship does a slow perfectly banked turn. In one case, according to our airline pilot friend, the aircraft did a complete 180° before the navigator caught it! Responsible aircraft commanders must insist on constant monitoring, using all the facilities so expensively provided him. A responsible commander also will encourage all crew members to monitor him.

SKYWAYS FOR BUSINESS



DE HAVILLAND DOVE, *photographed here off coast of Japan, is one of several business aircraft owned and operated by Mainichi Shimbun, periodical publishers in Japan*

Japanese Publishers Add Dove to Business Fleet of Aircraft

Tokyo, Japan. News-gathering by plane is standard operating procedure for the Mainichi Shimbun, well-known publishers of newspapers and periodicals in Japan. The company recently acquired a de Havilland *Dove* which was flight delivered to Japan from the de Havilland factory in England by way of India, Bangkok, Manila and Okinawa. The plane was flown to Japan by Mr. P. Nock of British Aviation Services, and Mr. H. Cole of that same company went along on the trip and served as radio officer. Chief pilot for Mainichi is T. Shizura.

Mainichi Shimbun established its first Aviation Section in 1924 in Osaka, and later purchased a Twin Beech, a Lockheed, a Ryan, a British Percival and a Breda for its use in gathering news from all over the Orient.

At the present time, the company owns and operates a Cessna 195, a Piper *Super Cub* and a Bell helicopter in addition to the recently acquired de Havilland *Dove*.

Mechanics Design, Build Own Engine Run-In Test Stand at Dallas

Dallas, Texas. A simplified run-in stand has been devised by the mechanics and pilots of Magnolia Petroleum Company, Love Field. Built at a cost of $125, the test stand for Continental C-90 engines that power Magnolia's four pipeline patrol Luscombes saves an estimated $100 to $125 per week and an average of 40 hours work time on each engine.

The stand's design is so simple there are only three bolts and nine miscellaneous connections involved in the operation of putting the engine on the test stand. One man can handle an engine test and change by himself. The complete changeover takes only four hours, including putting the prop back on the plane.

Controls for the run-in are on a panel on the back of the stand, and there is enough gasoline in the container mounted on top of the stand to keep the engine running for an hour and a half. Casters on the stand make it possible, winter or summer, to be rolled out onto any vacant ground and staked down during a test run. A fire extinguisher is fastened to the bottom righthand side the stand, but thus far in operations it h not been necessary to use it.

Magnolia Petroleum has two spare engir for its fleet of four pipeline patrol aircra After each C-90 engine has accumulated 5 or 600 hours, it is disassembled and sent Southwest Airmotive's engine shop for pa inspection. Magnolia's mechanics are th told which parts should be replaced a which reworked, and the engine is then ma ready for reassembly and its test run on t run-in stand.

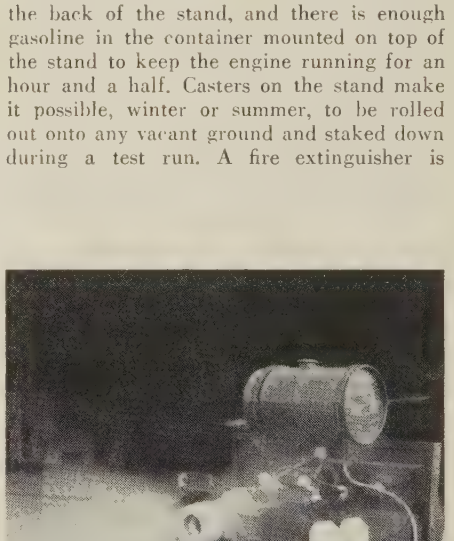
Bill Linn, chief mechanic for Magnolia, ports he has seen other run-in stands arou the country, but that this one devised by Magnolia crew is one of the neatest and m versatile anywhere in the industry.

The Luscombes fly an average of 7500 r enue pipeline-miles per week, and these a planes along with the company's multi-engi business transports are hangared in spa leased the company by Southwest Airmoti

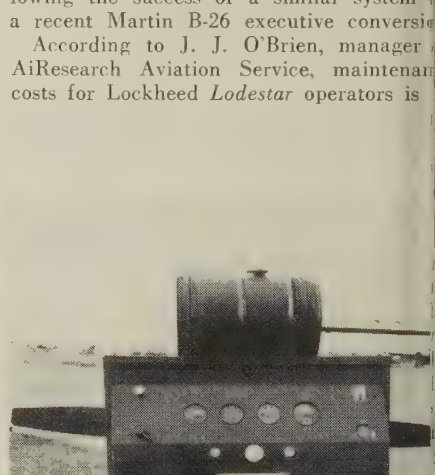
Nylon Pliocel Fuel Bags Replace Integral Wing Tanks on Lodestar

Los Angeles, Cal. Engineering was recen completed by AiResearch Aviation Serv for the installation of Goodyear nylon plio fuel bags on Lockheed *Lodestar* aircraft f lowing the success of a similar system a recent Martin B-26 executive conversi

According to J. J. O'Brien, manager AiResearch Aviation Service, maintenan costs for Lockheed *Lodestar* operators is



CONTINENTAL *C-90 engine is shown here being run-in on the test stand built by mechanics of the Magnolia Petroleum Company*



CONTROLS *for Magnolia's run-in test sta are on panel on back of the stand. Tank top holds enough gas for hour and half r*

ed by installing these fuel cells because it minates the periodic re-seal jobs that are essary on integral wing tanks. The nylon ocel fuel bags last indefinitely and be- se the need for constant inspection and airing of small leaks as required by the system is eliminated, the fire hazard from ky integral tanks is reduced and the safety tor is increased.

Replacing the integral wing tanks with the on pliocel fuel bags, plus an additional in the outer wing panel, increases fuel acity to 670 gallons. By adding three re fuel cells, 850 gallons may be carried. A change to a dual fuel system is accom- shed by inter-connecting the two outboard l cells into one unit and inter-connecting one to four outboard fuel cells.

Goodyear has several Lockheed *Lodestars* its fleet and the first of these aircraft are w at AiResearch for the conversion from egral wing tanks to Goodyear nylon pliocel l bags.

ecutive-Pilot Course Offered Univ. of Miami, Embry-Riddle

Miami, Florida. To meet a growing demand industry for management and executive inees with specialized collegiate training aviation, the University of Miami has es- lished two courses of study in conjunction h the Embry-Riddle School of Aviation. is announcement was made in a joint state- nt by Dean Grover A. J. Noetzel of the iversity of Miami School of Business Ad- nistration, and L. D. Carlton, Dean of Ad- sions at Embry-Riddle.

Enrollments are now being accepted for l classes in a full four-year course leading the BBA degree, with a management major aviation administration. In addition to ndard business administration courses, ining in aviation management is provided. e flight training portions of the program to be conducted by Embry-Riddle.

A more specialized two-year executive-pilot siness course with a rigorous measure of onautical technology and flight training l also be available in the fall. This course l ready the student for CAA certification a commercial pilot, with instrument and lti-engine ratings, and a certificate of suc- sful completion will be awarded by the iversity of Miami. University credits will ply toward the BBA degree.

The executive-pilot course of study is de- ned to provide the best possible back- ound in minimum time in a wide range technical aviation phases as well as the sic business and management training so ential to success in any aviation executive management career.

ssna Names Executive Aircraft Distributor in Missouri Area

Kansas City, Mo. Executive Aircraft Com- ny, Kansas City, Mo., has been named a ssna Distributor by Cessna Aircraft Com- ny, Wichita, Kansas. Executive Aircraft ers complete aircraft service and can boast the only CAA certified aircraft repair serv- in the 5th Region. Lee Florence and Ned hop will solicit business throughout the stern half of Missouri and several eastern unties in Kansas.

....in the Business Hangar

Chief Pilot Tony Zuma, Tennessee Gas Transmission Company, is back at his company's home base with a second Martin B-26 converted by AiResearch Aviation Service, Los Angeles. The airplane underwent a 70% modification of structure and mechanical components in the process of executive conversion, and was delivered to Tennessee Gas Transmission after only one and a half hours of test flying. Tony Zuma is his company's National Business Aircraft Association representative.

The F. C. Russell Company of Cleveland, Ohio, has added a deluxe DC-3 to its fleet. The Russell Co. traded in one of their D18S airplanes for this Remmert-Werner converted Douglas. Company pilot is Clint Bacastow.

A. L. Dougherty Construction Company, of Indianapolis, Indiana, has purchased a Lockheed *Lodestar* from Powers & George, aircraft brokers in New York City. The *Lodestar*, formerly owned by Cornbelt Hatcheries of Joliet, Illinois, will be used in conjunction with a Lockheed 12-A on Dougherty Construction Company business.

Betty Hebbler, pretty hostess of the J. R. Watkins Company DC-3, was a recent visitor at AiResearch, along with company pilot Jack Ollam and copilot C. E. Hebbler, when they brought the company's business DC-3 to AiResearch for mechanical work. Home port for the DC-3 is Winona, Minnesota, and Ralph Boalt is the Watkins Company's NBAA representative.

The B-23 owned and operated by National Distillers recently added a Flite-Tronics MB-3 Marker Beacon receiver which was purchased from Smith-Meeker Engineering Co., New York.

Lycoming-Spencer's *Twin-Bonanza* is back in operation after installation of a complete L-2 Auto Pilot, including Altitude Controller and Automatic Approach Coupler. Work was done by Reading Aviation Service, Inc., Reading, Pa., and the airplane was brought to RAS by Lycoming-Spencer's company pilot, Marty Ault.

Ernest K. Gann, author and former American Airlines and Transocean Airlines pilot, is in California writing the screenplay of his best-seller book, "The High and the Mighty." Warner Bros. Pictures, Inc., is to make the movie.

Armstrong Cork Company's DC-3, "Orion 11," brought Pilot J. C. Yost, Copilot L. E. Hemmer and Kirk Painter, vice president of the flooring and industrial division of Armstrong Cork, to Dallas and the Southwest Airmotive ramp. John Yost is also the company's NBAA representative.

Clyde Barrow and Buford Beech, pilot and copilot of the Skylark Twin-Beech that is based at Southwest Airmotive, are trying their luck with the flyrods at East Yellowstone, Wyoming. No report has come through yet regarding the trouts' cooperation . . . or lack of it.

Warren Petroleum Corp., Tulsa, Oklahoma, recently added a Flite-Tronics MB-3 Marker Beacon receiver to its company Twin-Beech. Aircraft Radio Sales of Tulsa made the installation.

Bill McAfee and Chuck Hinksman brought W. A. Crockett's PBY5A to AiResearch Aviation Service for an exterior paint job and miscellaneous overhaul. The plane is based at Fresno, California.

Mathieson Chemical Corporation's Riley *Twin-Navion* has been in the hangar at Reading Aviation Service for minor maintenance work. Pilot Neil Fulton brought the plane in from Baltimore. Neil also is Mathieson's NBAA representative.

Bill Hoban brought Olin Industries executive DC-3 to Remmert-Werner at St. Louis for engine changes and a new paint job—white top, grey wings and lower fuselage and a blue stripe. Home base is East Alton, Illinois.

Official NBAA Report

NATIONAL BUSINESS AIRCRAFT ASSOCIATION, INC.

(formerly Corporation Aircraft Owners Association)

National Business Aircraft Association, Inc. is a non-profit organization designed to promote the aviation interests of the members firms, to protect those interests from discriminating legislation by Federal, State or Municipal agencies, to enable business aircraft owners to be represented as a united front in all matters where organized action is necessary to bring about improvements in aircraft equipment and service, and to further the cause of safety and economy of operation. NBAA National headquarters are located at 1029 Vermont Ave., N. W. Washington 5, D.C. Phone: National 8-0804.

New NBAA Directory of Business Aircraft Released

Copies of the new NBAA "Directory of Business Aircraft" recently were distributed to Association members. The permanent binder, loose-leaf format now being used was planned to facilitate quick reference to its contents. All aircraft listed therein are owned and operated by the NBAA membership.

The Directory was first published in January 1950, to more readily identify aircraft flown by member-pilots and to indicate the type of communication and special equipment carried. The Directory also is designed to help reduce the increasingly heavy communications load being imposed on the Federal airways system and to speed the filing of flight plans. Copies have been distributed to all CAA Air Traffic Control Towers and airways personnel as well as to USAF Air Defense Identification Zones personnel.

To make the Directory easy to use, type of member's aircraft and registration number have been arranged numerically in the first section of the publication. An alphabetical listing of the membership is included in the second section along with the type of aircraft operated, the member's Association representative, their pilots and mechanics. Tabs are provided to speed reference. Each quarter, the contents will be brought up-to-date by supplementary sheets which will include new members and aircraft, personnel changes, added equipment, and other additions and deletions.

CAA Announces Reduced Price for Airman's Guide

Reduction in the annual subscription price of the *Airman's Guide* from $6.00 to $4.75 domestically and from $8.00 to $6.25 for foreign mailings recently was announced by the CAA. This new price for the publication is effective immediately and includes 26 copies of the *Airman's Guide*, published every other week, and one annual copy of the Flight Information Manual.

Since it was first published in its present form in April 1946, the *Airman's Guide* has proved a valuable aid to business pilots. Actually, it is three publications in one, containing a tabulation of Radio Aids, Directory of Airports and Notices to Airmen.

The Radio Aids Section shows the location of all the air navigation radio aids by State, location and pertinent information on all radar aids and instrument landing systems.

The Directory of Airports lists all the civil airports in the country by type, location, elevation, number of runways and length of longest at each airport, type of fuel available and miscellaneous remarks.

The Notice to Airmen section gives important temporary information regarding airways and airports including corrections and changes in the Flight Information Manual.

The Flight Information Manual carries such essential information as airspace reservations, air traffic control procedures, danger areas, standard approach procedures, a listing of the standard broadcasting stations, Weather Bureau services available and minimum enroute instrument flight rule altitudes.

The *Airman's Guide* is on sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

"Theoretical" CAA Lights Prove Practical Flight Boon

Theory and practice have met in a happy union at General Mitchell Airport at Milwaukee where a new type of high intensity runway light is pleasing pilots and lighting engineers with its performance in bad weather conditions.

The theory of the light came from "paper work" by lighting engineers of the Technical Development and Evaluation Center of the Civil Aeronautics Administration at Indianapolis, Indiana. The actual lighting fixture came out of the shops of the Line Material Company of Milwaukee, which has been carrying on an independent development in their own research laboratory. The result is a system of runway lights now installed at Milwaukee for study under actual operating conditions. They outline the runway for the pilot throughout his approach and landing.

Pilots of business aircraft holding at Milwaukee during a recent low visibility period praised the help which the lights gave in the last moments of their landings. Measurements of the amount of light given by the units at 50% brightness for circling approaches indicate that the units come within 10% of meeting the theoretically perfect conditions set up by the engineers who worked out the candlepower requirements on paper. Of this 10% only 1.5% is in a critical angle.

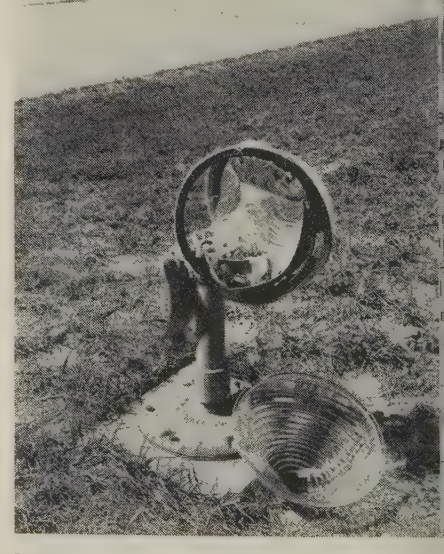
As visibility becomes less, the traffic controller increases the intensity of the light. This increase automatically changes the angle of the main beams in the unit and directs the brighter light down the runway more directly toward the approaching plane. This change in "toe-in" is accomplished automatically without the use of motors.

CAA lighting engineers, cooperating with the CAA Office of Airports, worked out the requirements for the "perfect" runway light by plotting the paths of typical transport planes in good weather and bad weather approaches. They published their findings last year in Technical Development Report No. 178. Line Material Company engineers were working on an improved runway light at the time and, when they read the report, realized their light was close to meeting the theoretical requirements of the CAA report. Engineers believe that slight modifications will enable the light to fill the bill. The tests at Milwaukee will continue for several months.

General Mills Develops V.G.A. Flight Recorder

NBAA member, General Mills, Inc., Engineering and Research and Development Department, Mechanical Division, Minneapolis, Minn., has developed the Ryan V.G.A. (Velocity-Acceleration-Altitude) Flight Recorder after several years of extensive research and experimentation.

The V.G.A. Flight Recorder is an instrument for continuously recording indicated airspeed, static pressure-altitude, and vertical accelerations of aircraft for long operating periods. The purpose of the instrument is to define the instantaneous airspeed, the vertical acceleration and the altitude at any given instant of time. This information, when correlated with time, establishes the indicated altitudes of the aircraft in flight, the roughness of the air currents, and the airspeed at which the disturbances occurred. Data from many flights may be compiled to determine standard flight paths and the effects of atmospheric disturbances upon them. Abnormal forces on



RUNWAY LIGHT *one of 102 new high intensity lights at Gen. Mitchell Field, Milwaukee, Wis.*

craft may be measured, and conditions ior to air crashes and other difficulties may recorded.

For complete design specifications and details of operations, write to General Mills, c., Engineering, Research and Development Dept., Mechanical Div., Minneapolis, inn.

OR Interference Caused by HF Communications Receiver

Reports have been received by the CAA herein erratic flag and cross-pointer operation has been traced to interaction between e VOR receiver and the receiver portion of e VHF communications unit. This interaction gives the pilot the impression that the OR receiver is defective or that the ground cility is providing a weak and unreliable gnal. This condition can be determined by itching the VHF communications unit to other channel, thus removing the interfering signal. Although current reports indicate lack of heterodyne, such as experienced hen two high frequency stations are transitting at the same time, such heterodyne is ossible.

Reports received so far indicate that trouie has been experienced only with the ARC-1 d ARC-3 communications units. However, milar difficulties may possibly result from her VHF communications receivers.

Interferences may be experienced in some stallations when the ARC-1 is set approxiately 9.7 mc above the VOR channel being ed or the ARC-3 is set approximately 12.0 c above the VOR channel.

With a VHF communications receiver of fferent design, interaction may result when e difference frequency (above paragraph) of some other value and may possibly occur frequencies below or above the omni channselected, depending upon design characterics. Selection of a different communications equency should eliminate the difficulty.

Reminder—New CAR

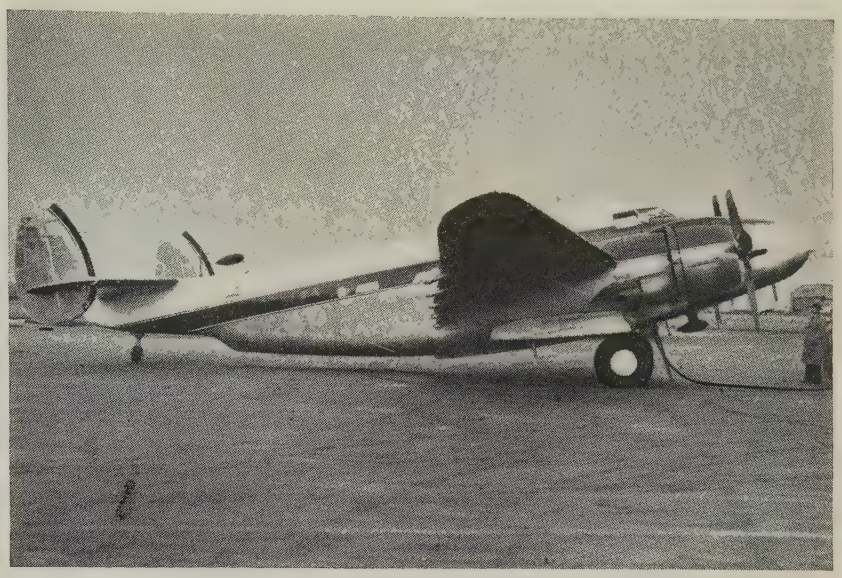
A Civil Air Regulation Amendment 60-1, hich is now in effect, reads that aircraft ying along a L/MF airways shall be flown the right of the center line of such airway, nd when flying along a VOR airway the aircraft should be flown on a radial designated forming the center line of such airway, nless otherwise authorized by Air Route raffic Control.

Aero-Industry Group Named to Study Federal Airport Program

A thorough evaluation of the Federal Airort Program is being made for the Departent of Commerce by a group of aviation inustry officials chosen for this purpose by obert B. Murray, Jr., Under Secretary of ommerce for Transportation.

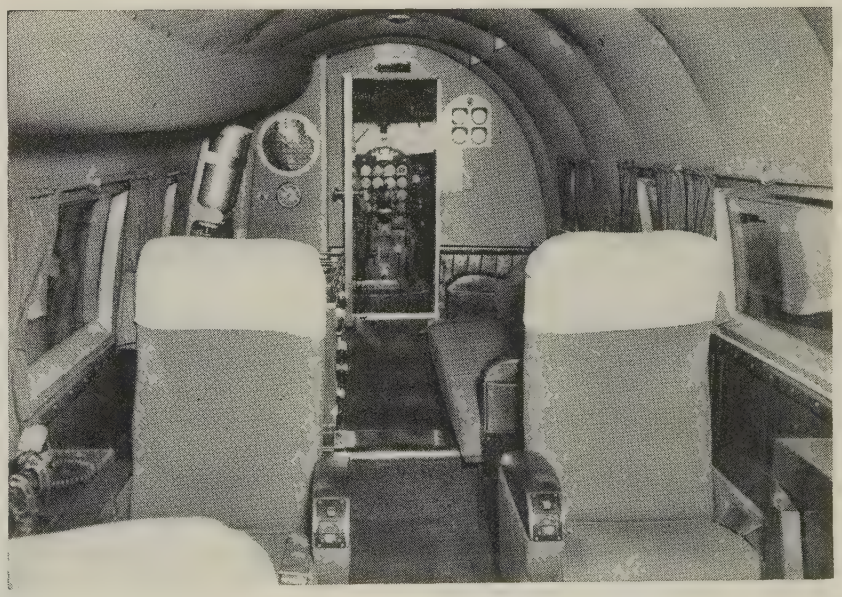
Chairman of the group is Jennings Randolph, assistant to the president of Capital irlines, while the secretary is Melvin H. uss, director of the Reading (Pa.) Municial Airport and Treasurer of the American ssociation of Airport Executives.

Other members of the panel are Jean H. DuBuque, Executive Director, National Busiess Aircraft Association; Milton W. Arnold, ice president of operations and engineering, ir Transport Association; Francis A. Bolton, uperintendent, Port Columbus (Ohio) Airport; I. B. Durand, Secretary and assistant general counsel, ATA; Louis R. Inwood, Director, Division of Aviation, Philadelphia, Department of Commerce; Foster V. Jones, Director of Airports, Louisville and Jefferson County (Ky.) Air Board; A. B. McMullen, executive secretary, National Association of State Aviation Officials; Donald W. Nyrop, counsel, Conference of Local Airlines and former chairman of the CAB; R. W. F. Schmidt, manager, Tucson (Ariz.) Airport Authority; Thomas K. Taylor, vice president, Trans World Airlines, and J. B. Hartranft, president, AOPA.



QUAKER RUBBER PV-1

Formerly a Navy patrol plane, this Lockheed PV-1 is now doing duty as a business plane, owned and operated by Quaker Rubber Corp. Based at Pittsburgh, the plane is piloted by Harry Snow (right); *Howard Aliff is copilot. It seats eight passengers and included in equipment are dual ADF, Zero Reader, MN-53 Marker Beacon, Sperry Engine Analyzer, etc. A Janitrol heater is located in rear of fuselage. Powered by two R-2800-31 engines, plane cruises at 230 mph; is flown some 40 hours a month. Quaker is member of NBAA.*



NAVIGATE WITH PRECISION AND EASE...

Enjoy positive, simplified navigation, whether you have an instrument rating or not. A Lear ADF gives you over 2500 stations to home on. Just tune to a station—quickly and automatically, the needle swings and points the direction to fly—plotting a fix is also just as quick and positive.

FOR SINGLE OR TWIN...

Whatever you are flying, you can now have a great new Lear ADF that meets your weight and performance requirements. Your Lear dealer will be happy to advise you which system is best suited to your needs. If you're buying a new plane, have your Lear ADF installed at the factory.

FERRO-DYNAMIC® LOOP!

Only Lear ADF's are equipped with this new brilliant performing, high-speed loop. It is more compact, has greater sensitivity, is completely enclosed in a molded housing, sealed against dust and moisture.

The ORIENTER® ADF-12

A combined ADF, three-band broadcast, radio range and communications receiver. Weighs less than 18 pounds and provides modulation and power for extra VHF transmitter.

The *Executive** ADF-14

Deluxe Model, rugged and dependable, well-suited for multi-engine planes. Has tuning meter, BFO—can be hooked to dual azimuth indicators. Sealed components, fungus-proofed.

*Trademark

ATTENTION PILOTS!

Send for ADF log—alphabetical listing of 2500 standard broadcast stations, range stations, radio beacons, ILS locators, and control towers—giving frequency, power, location, type, etc. Price $1.00.

Name_____

Street_____

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LEAR, INC. *LEARCAL DIVISION*
11916 WEST PICO BLVD., LOS ANGELES 64, CALIF.
GRAND RAPIDS DIVISION, GRAND RAPIDS, MICHIGAN;
LEAR-ROMEC DIVISION, ELYRIA, OHIO; LEAR INTERNATIONAL
EXPORT CORP., 9 EAST 45th STREET, NEW YORK 17, NEW YORK.

New Compact Ground Station Receiver, S220A

There is always room for an improved mouse trap even if the world won't beat a path to your door for same. In the field of communications, aviation ground stations have not yet reached a point where a more compact VHF receiver, without sacrificing quality, reliability or performance, is no longer interesting. Airways and airport facilities' needs are obvious and familiar. Less familiar but growing in importance is the need for company monitor stations so that corporations and non-governmental organizations operating aircraft can keep constantly informed operationally of the status of their airborne units even if the need doesn't exist for a complete company-owned two-way communications network.

Such a receiver, to monitor airways and approach status communications messages in the company interest as well as to receive direct company messages on assigned frequencies, is the new SCHUTTIG S220A, covering any preset crystal-controlled frequency in the desired band.

Requiring 40% less rack space than other VHF receivers available, 1 microvolt signal modulated 30% provides 1 watt audio output at 10 db or better signal-to-noise ratio. Selectivity ranges from 20 kc at the 6 db point to 100 kc at the 60 db point. The quick-response squelch circuit operates at levels as low as 1 microvolt, to quiet the receiver except when signals of desired strength are received, rejecting noise at lower levels.

Even at these low levels, squelch action is switch-like in speed and cleanness of action, according to the manufacturer, SCHUTTIG & CO., Inc., of Washington, D. C. Automatic volume control (AVC) action keeps the receiver output constant within 1 db at all input levels between 5 and 200,000 microvolts. The face panel is designed for easy installation in established communications receiver racks.

PHF GROUND STATION *receiver for company monitor station has been announced by Schuttig*

CAA Brings Out Paper on Omni-Receiver Test

The Civil Aeronautics Administration recently released an important paper entitled, "Testing Your Omni-range Receiver." In case a copy has not come your way, we herein reprint that paper in its entirety for your perusal:

Your omnirange receiver, like your compass, is a mighty useful piece of flying equipment—as long as it tells you the truth. But its usefulness ends in a hurry when it starts telling you fibs. Under IF conditions, an omnirange receiver which gives substantially false indications can be hazardous to you and to others who share the airways system.

To help you home safely, the Civil Aeronautics Administration now provides simple means of checking your receiver periodically. If you use your omni receiver for instrument flying, you should make such a check every 10 days or 10 hours of flight time, whichever is less. Even if your flying is VFR, periodic receiver tests are a good common sense safety precaution. A truthful VOR receiver can be a friend indeed in emergency situations.

Testing Methods

There are several ways of testing your receiver which will make you socially acceptable on the airways. They should be made in the following order of procedure, depending on which is available.

1. By CAA test signal. (Available at only a few airports).
2. By testing at a designated check point on an airport.
3. By checking one set of a dual receiver against the other.
4. By airborne check of the receiver under VFR conditions.

How do you find out if there is a test signal or designated check point at an airport?

These are listed in the *Airman's Guide*. If your most recent copy was lost or stolen, inquire of the airport management. The man in the tower, if he isn't too busy, will be glad to tell you where the check point is.

CAA Test Signal

If there should be a CAA test signal at the airport, you won't have to go anywhere for your check. Just turn on your receiver and let it warm up for five minutes. Then tune in the omni channel used for the test signal. With the needle centered, the bearing indication should be 0 degrees FROM, or 180° TO.

The chances are it won't be quite perfect. A reasonable tolerance is 4° plus or minus. If the error is greater than 4°, some maintenance work is in order.

In this test, as in the others described later, it is imporant to check on receiver sensitivity. There should be no flag activity (if your set is equipped with that type of indicator). With other kinds of receivers, the needle should go full-deflection to the TO or FROM indication.

Airport Check Points

At a large number of airports, the CAA has designated a check point for VOR receivers. This is a point where a reliable signal is received from an omnirange in the general vicinity. The check point may be near the ramp, on an exit taxiway, or other convenient location.

A sign at the check point will give the correct TO and FROM courses; for example: "DCA 176-356." Some of

(Continued on page 34)

CAA Brings Out Paper on Omni-Receiver Test

(Continued from page 33)

the check points may have circles on the ground to show where to park for the test. Otherwise, the check can be made at any point conveniently close to the sign.

The test is simplicity itself. After the five-minute warmup, tune in the omni frequency required and turn the azimuth selector until the needle centers. Either the TO or the reciprocal FROM bearing may be used. No special aircraft heading is required. If the error is less than 4° plus or minus, you may go your way rejoicing.

Dual Receivers

Should you be fortunate enough to own dual VOR receivers, and no designated check point is available, you can check one receiver against the other on any omnirange. The readings should agree within plus or minus 4°. Should the variation be greater than 4°, the receivers can be checked by some other means. If one is within the 4° tolerance, that receiver should be used for instrument flight.

Airborne Tests

Should no ground check points be available, you can make an airborne check. The CAA may have designated some nearby landmark as a check point. If so. this should be used.

Within the receiver warmed up, fly toward the landmark on a course approximately to or from the omnirange. When you are over the landmark, center the needle, and see how much the azimuth selector reading varies from published bearing at the check point.

Since there are more uncertainties in an airborne test, the tolerance here is plus or minus 6°.

If no ground or air check points are provided in your area, you may set up your own. You do this by examining a chart and finding a prominent landmark on a published VOR radial. It should be 20 miles or so from the VOR station.

Fly over the selected landmark at a reasonably low altitude. If the difference between the indicated bearing and the published bearing is less than plus or minus 6°, your receiver is in acceptable condition.

Manufacturer's Calibration

Some manufacturers of VOR receivers provide a card giving small plus or minus corrections which should be applied to specific bearings. These corrections may be added or subtracted in determining whether your receiver is within tolerance. No corrections except those provided by the manufacturer should be applied in the tests.

Air-Aids Spotlight

VOR's

ALMA, Ga. *VOR may still be inoperative.*
BRUNSWICK, Ga. *VOR should resume on 114.2 mc.*
TUCSON, Ariz. *VOR due to resume after relocation.*

RADIO BEACONS

CHATTANOOGA, Tenn. *The relocated Outer Marker Compass Locator on 215 kc now 8.9 mi. from approach end of the ILS runway to be called NORTH CHATTANOOGA. Identification, if changed, and approach altitude not announced.*
COLUMBUS - ATTERBURY, Ind. *AFB MHW Beacon shut down* in IFR conditions *to prevent unauthorized use.*
MANAKIN, Va. *Frequency change cancelled, charts should still show 341 kc.*
MIAMI, Fla. *The MH beacon at MASTERS MCAS keys "NIG" on 382 kc.*
MYRTLE BEACH, S. C. *New radio beacon (BMH class) on 236 kc.*
NEW BERN, N. C. *New BMH beacon on 391 kc.*

RANGES

BRYAN, Tex. *should resume on 272 kc as simultaneous.*
MADISON, Wis. *Four-course range rotated 40° counterclockwise; magnetic bearings toward station now 4A 94N 184A 274N.*
NORFOLK, Va. *Frequency change delayed, charts should still show 239 kc, not 236 kc which would have conflicted with the proposed assignment of 239 to Manakin, Va.*

ILS CHANGES

MADISON, Wis. *ILS to serve the N/S runway on 109.9 mc; altitudes over LOM and LMM 1,917 feet and 1,058 feet.*
MASSACHUSETTS Area—*Another swap around.* WORCESTER *ILS Localizer and Glide Path now on 108.1 and 334.4 respectively, releasing 109.5 to the* BEDFORD (BOSTON) *ILS.* NEW BEDFORD *ILS remains on 109.7 mc.*

ATC FACILITIES

Initial tower contact instructions vary with the location. BOSTON and WASHINGTON *like VFR traffic to contact tower solely on approach,* LaGUARDIA and PITTSBURGH *request VFR as well as IFR traffic to contact Approach Control first.*
BOSTON *Radar Departure Control on 120.5 mc.*
BRIDGEPORT, NIAGARA and WESTCHESTER *towers given temporary stay of closing via intervention of local civil, industry or military interests.*
WHEELING, W. Va. *tower inaugurated pending plans for Combined Facility employing existing facilities plus 119.1 two-way, and receiving only on 3105 and 3023.5 kc. Only low-frequency voice is on the Compass Locator on 275 kc which at press time was keying a monotone in lieu of the identifier.*

For more complete and later information on changes and facilities status, check AIRGUIDE, RF and JEP manuals.

Bad News

If a test shows that your receiver is outside the required tolerance, you needn't visit a loan shark or sell the family car. Most ailments of VOR receivers are no worse than a common cold, and much more quickly cured. But whatever you do, don't get out the hammer and screwdriver and begin work on the set yourself.

It is impossible to calibrate a VOR receiver without special test equipment made for that specific purpose. Take your receiver to a shop which has the equipment and plenty of experience in the omni field. The job will be done quickly and efficiently, and at low cost.

Maintenance Tips

The most important single thing you can do to keep your VOR receiver healthy is to operate it only at the correct voltage. That means you *never* start the engine when the receiver is turned on. It also means to use electrical accessories in such a way that generator and battery are not overloaded.

Most small VOR receivers draw 8 to 9 amps at a nominal 12 volts. Actual voltage should be between 13.8 and 14.2. Using the receiver at voltages above 14.5 can cause damage and shorten the life of tubes and other components. Low voltage can reduce receiver sensitivity and cause false readings in some types of

VOR receivers now on the market.

Installing a good voltmeter, if there is none now in the plane, is inexpensive insurance against inadvertently using so much electrical equipment simultaneously that voltage drops to dangerous levels. Correct voltage is as important to the life of your radio communication equipment, incidentally, as it is to the VOR receiver.

Electrical "noise" frequently produces false VOR readings. To avoid this, a clean electrical system, carefully bonded (not just grounded) is necessary.

Antenna location may effect accuracy in some instances. Better not force your novel ideas on an experienced installation man.

Most inaccuracies in VOR receivers develop gradually. Sudden error can appear, but it is extremely rare. Slow deterioration of parts is the usual cause of erratic readings.

Tubes should be replaced when they drop below certain limits, of course. But putting in new tubes indiscriminately may cause more trouble than it prevents, since most sudden tube failures occur in the first 20 hours or so of service. Also, in many instances, new tubes will change the calibration of the receiver, and require retuning of associated circuits.

Most VOR receivers have a small amount of "reciprocal error." That means that the TO reading may not be exactly 180° different from the FROM reading at the same location. If the difference is only a degree or two, you can forget it.

Aircraft Antenna Lightning Protection

A device to protect aircraft antennas, movable surfaces and radar equipment against damage by lightning was described at the Summer General Meeting of the American Institute of Electrical Engineers in Atlantic City this June. The device, it was explained by three engineers, also affords valuable data on lightning discharges, although this may be of lesser importance to the pilot seeking elimination of the condition rather than a talking point after completing an instrument flight without benefit of radio.

Although "transport aircraft *(and other all-metal aircraft*—Ed.) are inherently provided nearly complete thunderstorm discharge protection by the metal fuselage which forms a safe path for the discharge currents that the aircraft may intercept," external elements and radio equipment may be damaged and fires started. Some known catastrophies and others suspected, have been charged to this factor. The paper was presented by J. M. Bryant of the Univ. of Minnesota, and M. M. Newman and J. D. Robb, of the Lightning and Transients Research Institute, Minneapolis, Minn.

The device consists of 1) a capacitator with approximately 10 times the capacity of the antenna, placed in series with the antenna lead-in wire as close to the feed-through insulator as possible; 2) an exchangeable spark gap cartridge to provide ground from the antenna side of the capacitator to divert the discharge current to the structural side of the airplane; and 3) steel strips for recording crest current values by the degree of their magnetization. Analysis of the sphere gap pitting after a lightning discharge indicates the total charge transfer.

Fifty of the protective (and recording) units have been placed on American Airlines aircraft during the past two years, affording protection and valuable information, and are being made available to others, the authors said. Additional information on lightning strikes also has been obtained from questionnaires filled out by pilots whose aircraft have been struck. The audio crash in the radio receiving equipment and blinding visual effects have been commonly described. An airline pilot whose antenna was only recently torn away by a strike additionally described a definite physical jolt that he referred to as not unlike "a super kick-in-the-pants!"

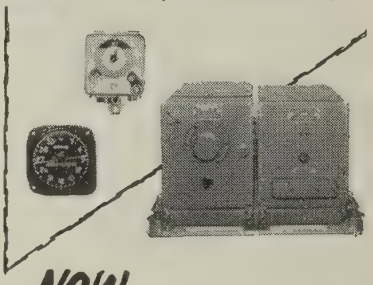
New types of protection units are being developed for VHF stub antennas and for high-altitude operations, it was reported. Now, if they can stop those VHF whips from doing the St. Vitus dance when loaded with ice or rain, a lot of pilots will be happier.

Civil VHF/DF Facilities

CAA VHF/DF facilities are now available on most common civil VHF frequencies at the following locations. It should be noted that they are primarily at locations at which a considerable volume of military air traffic exists. It should also be noted that in some cases the associated airport may be closed to civil aircraft and, except in emergency, only position reference information may be given and not a "steer" to the associated airport.

Akron Municipal Airport, O.
Burlington, Vt.
Crestview, Fla. (Commun. Sta.)
Knoxville, Tenn.
Madison, Wis.
Niagara Falls, N. Y.
Greater Pittsburgh Airport, Pa.
Wichita Air Force Base, Kans.
Wilmington, Del.
Washington, D. C. (Tower)
Washington, D. C. (Air Route Center)
Chicago, Ill.

To use or test this civil service, call the associated tower, except as noted, on the published frequencies and if operational duties do not preclude, the value of the service may be demonstrated.

Aircraft Radio Corporation
VHF NAVIGATION EQUIPMENT

NOW... pilots of medium and small type military planes, as well as private and executive aircraft, can have the safety and reassurance of OMNI reception. Compact, static-free and dependable, the Type 15-D gives you a visual signal to follow, no matter what your bearing may be to or from an omni station. Also provides use of both visual-aural ranges and amplitude runway localizers. Simultaneous voice feature included, and GCA voice reception. Tunable receiver to select any VHF aircraft frequency in band 108 to 135 mc. CAA Type Certificated. Thousands in service. Get the details.
Dependable Airborne Electronic Equipment Since 1928
ARC
Aircraft Radio Corporation
BOONTON NEW JERSEY

Dual VHF Navigation Out-Distancing Current DME Development

Despite accelerated development programs of both government and manufacturers alike, plus such service tests of DME as the Mohawk Airlines route installations, evidence is increasing that the air carriers and other large users of the nation's airways are investing heavily in Dual VOR equipment to go on a complete VHF navigation basis, with its many advantages, without waiting longer for large-scale production promises for DME equipment. Present indications are for target dates of mid-1954; airborne equipment lightest weight—30 lbs; lowest cost $4,000-$5,000 per unit.

In-practice operational techniques of Dual VOR navigation are emerging daily as pilots become more familiar with the equipment. As often happens, procedures acceptable for ATC use are being perfected by the pilots themselves for approval by government agencies instead of the other way around.

There is just so much room and weight available in even large commercial aircraft for navigational equipment. Although, like airborne radar and beacons, DME production lines will find a ready market, it is significant that Collins Radio Company can announce they have contracted to equip the largest domestic airline fleet (American Airlines) with Dual VOR installations of the Collins 51R VOR receiver, 51V Glide Slope receiver and instrumentation.

Convair has also ordered from the Collins Company complete navigation and communications systems for 57 of their '340 aircraft now in production, consisting of three 51-R receivers, two 18S-4 Communications transceivers and associated equipment to total 17 equipment units per installation.

NARCO Unveils Production DME Receivers

Although a specific target date was not set, NARCO has issued a special bulletin inferring that the production version of their DME will be on the market this winter. The company hopes that it will be the first production airborne DME available for general sale, and is expected to find its first operational use in business aircraft. NARCO has, therefore, keyed its design to the requirements of this market and the first NARCO DME will be remote controlled ½ ATR rack-mounted equipment weighing about 30 lbs. CAA type certification is comtemplated. Rugged ARINC tubes are being used throughout.

Distance is measured over approximately line-of-sight range to VOR or ILS sites equipped with DME ground stations. These stations are being installed all over the country by the CAA and it is expected that there will be a DME operating at all VOR sites and most ILS sites by mid-1954.

Operation of the NARCO DME is simple. A frequency selector switch consisting of two concentric switch dials numbered in megacycles and tenths from 108 to 118 is used to switch the equipment to the ommi or localizer frequency of the site to which distance is desired. This frequency selector may be eliminated if an airline-type VHF navigation receiver is already installed, and a single standard frequency selector can be used to switch both VOR and DME systems. When the aircraft is within line-of-sight range of this station, the distance indicator of the NARCO DME will read directly in miles the distance to the station selected. The NARCO distance indicator is a two-scale meter with an "enroute" range of zero to 200 miles, and an "approach" range of zero to 20 miles. The enroute range will measure distances up to 200 miles if the altitude of the aircraft is sufficient to provide line-of-sight coverage at this distance. Accuracy of indication on this scale is better than plus or minus 3% of the indicated distance and service tests to date have indicated that average performances will measure long-range distances within a couple of miles.

On the approach scale, the accuracy of the indicated distance is plus or minus ½ mile; and here again flight evaluation experience indicates accuracies on the order of ¼ mile or better.

The NARCO DME is inherently "fail-safe" by virtue of the fact that the needle on the distance indicator is in a continuous "searching" function when there is no positive distance signal to be indicated. Thus, in case of airborne equipment malfunction, ground station malfunction, out-of-range operation, or any other factor denying positive distance information to the indicator, the distance indicator needle will scan the selected range from zero to maximum repeatedly about every 40 seconds.

The NARCO DME measures slant range to any DME ground station within range so that the minimum distance indicated when crossing a DME station will be the altitude of the aircraft over that station in miles. This slant range is essentially the same as the ground distance at normal altitudes and distances greater than 10 miles or so. Thus, it is quite possible to note the time taken to fly a definite increase or decrease in distance along a straight course to or from the DME station and quite easily arrived at a ground speed figure.

The NARCO DME includes four sections plus a remote tuning system. A power supply provides the necessary voltages and current to the DME from a 12- or 24-volt aircraft DC supply. This power supply is a standard vibrator-transformer-rectifier-circuit. The total current drain is 9.5 amps at 13.5 volts or 5.0 amps at 27 volts. The balance of the equipment consists of the transmitter, the receiver, and the ranging unit, all of which (like the power supply) are mechanically and electrically demountable from the standard ½ ATR chassis with very little effort. The bulletin goes into considerable detail as to transmitter, receiver and ranging circuits.

The unit list price of the first NARCO Distance Measuring Equipment off the production line will be in excess of $4,000, but *not* more than $5,000. Delivery of these units will start late in 1953 and first units will be available for general sale shortly thereafter.

Aircraft radio service facilities in the field will be carefully trained by NARCO and this training will have been completed by the time NARCO production deliveries of Distance Measuring Equipment for general sale become available.

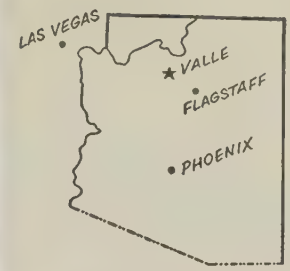
Adding New Radio Data to Charts Good Practice

Although much effort and money is expended to supply users of the nation's airways with the latest in navigational and communications facility information as quickly as possible, changes and additions are so many and frequent that it is a good practice to do a little personal editing of one's charts. Whether using Coast & Geodetic Sectionals, Radio Facility, Jeppesen Airways Manuals or other navigational references which are revised as frequently as is practical, there are always bits of additional information which, if self-added, will prove of value and be important, safety-wise. Although neither desiring nor in practice attempting to compete with those services, NAVICOM's Air-Aids Spotlight is designed to alert pilot-readers of SKYWAYS to these many changes and to emphasize certain of them.

We earnestly suggest that you not only refer to the above-listed facilities, the *Airman's Guide,* etc., for more detailed information, but make personal notations or amendments to your charts. CAA as well as other governmental agencies and private industry organizations already urge that pilots make notations of new landmark features like prominent drive-in theaters and the like, and to report them to these agencies.

Sectional charts, etc., list as many *Unicom* installations as are brought to their attention by the closing date for each periodic revision. However, as soon as a new installation comes to your attention, it should be added to your chart. Manufacturers of aircraft radio equipment (Narco, Lear, etc.) publish revised lists of such stations which can be obtained direct or via their sales and service dealers.

PLANE FAX



Your Best Week-end Flight Plan for September

This month plan a flight to the Grand Canyon—1009 square miles of fantastic cliffs and spires. Land at Valle Airport for bus service to the Canyon rim, and for quality Standard Oil aviation products.

Sightseeing by Air Inside the Grand Canyon

A bird's-eye view of the Grand Canyon from "inside"—that's daily fare for Al Hudgin of Hudgin Air Service. From his summer base at Valle Airport, he flies sightseers over 125 miles of the Painted Desert and the Canyon, probably the most rugged terrain in the West.

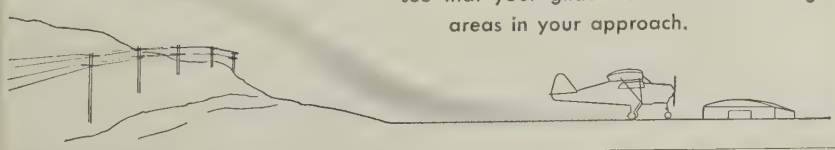
"I like to fly over scenery like this," says Mr. Hudgin, "as long as I can count on my plane. I'm always careful to check the plane myself. And we keep it filled with Chevron 80/87 Aviation Gasoline for extra take-off power and smooth cruising. It has never fouled our spark plugs.

"What's more, we keep our planes in top condition by using New RPM Aviation Oil. It gives us from 1000 to 1400 hours between overhauls—over 400 more flying hours than ever before. When we overhaul an engine that's used New 'RPM,' we find very little wear. Cylinder wear is less than a thousandth of an inch, even after such long service. And New 'RPM' eliminates pre-ignition and rough running due to oil while it keeps engines clean. We've never had a stuck ring or valve when using New RPM Aviation Oil."

T.M.'S "RPM", "CHEVRON," REG. U.S. PAT. OFF.

TIP OF THE MONTH

Don't try to stretch your glide when landing. Keep up your air speed so that you will be able to pull up if you see that your glide won't clear all danger areas in your approach.



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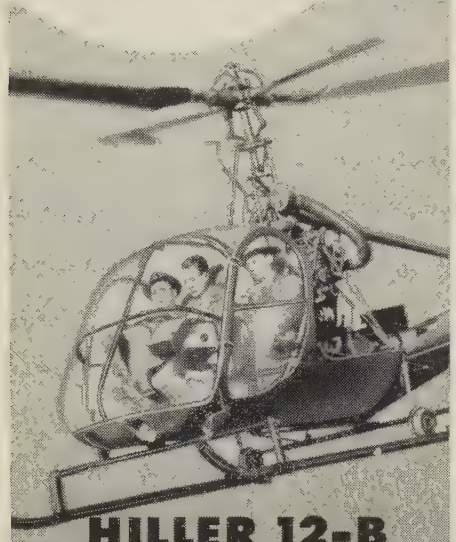

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...because of superior, exclusive features proved by more than four years of successful operation of Hiller helicopters—both commercial and military—in countries throughout the world.

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Hiller Helicopters, 1350 Willow Rd., Palo Alto, Calif.

*Reg. U.S. Pat. Off.

HILLER BUILDS A BETTER HELICOPTER

Engine Analyzer

(Continued from page 13)

are throttled back. The analyzer is so designed that it can give you a check on all four engines in only 20 seconds.

When the plane levels off at cruising altitude and after adjusting my power settings, I then take a more detailed look at the electrical system. This takes four or five minutes, and I repeat it every hour during the flight. It is a thorough check: plugs, mags, the whole works. If anything serious shows up, I can attend to it right away. Some types of malfunctions, particularly those involving mechanical failure (which often can also be detected by the analyzer), are highly critical. If the engine is not taken off power and its prop feathered within a very short time, severe and even dangerous difficulties ensue. With the analyzer, you actually carry on "preventive surveillance" in the air. The analyzer often shows up a weakness even before it becomes a malfunction.

As a matter of fact, some airlines have been a little leery of the analyzer for this very reason. Since the analyzer shows weaknesses before they become actual malfunctions, the flight engineer must be able to tell the difference. A timid flight engineer could conceivably ground a plane for enroute maintenance—thus losing time and money—when it could have continued to its final destination with perfect safety and then gone into normal turn-around maintenance. Experience, of course, is the answer. The experienced flight engineer learns in short order to differentiate between harmless "fuzz balls" and serious malfunctions.

Briefly, here are the advantages of the analyzer as I see them. First, it is versatile. You can use it on an aircraft with high-tension or low-tension ignition, with two or four engines. You can buy an analyzer which provides partial survey of an engine or a complete survey of all plugs in all cylinders. You can also buy a portable analyzer for use in ground testing. Any engine of 245 hp or above can utilize the analyzer efficiently.

The analyzer is not difficult to install. The job might be compared in complexity to installing an ordinary aircraft radio. The several compact units which comprise the device require only electrical conduit between them. The viewing scope and controls can be mounted conveniently near the flight engineer's station. The use of polariod screening keeps down the glare of the scope on a dark night when it might tend to reflect off the plane's windshield and annoy the pilot. By turning a vernier dial, the scope may be brought up to full brightness for easy interpretation on bright sunshiny days or when flying on top of an overcast in the daytime.

Interpreting the analyzer is something that improves steadily as a flight engineer works with it. However, the beginner can pick out basic malfunction patterns, using his standard book of drawings as a guide, after a 20-minute briefing. Sperry provides an excellent booklet which contains all of the latest patterns known to Sperry. This booklet—"*Engine Analyzer*," *Publication No. 23-117*—is furnished with each newly purchased analyzer and is useful, detailed and really practical. I use mine regularly in the air.

Sperry has set up a comprehensive service for the benefit of analyzer customers. Their Aeronautical Instrument School provides general familiarization with pattern interpretation and courses of instruction in the maintenance and overhaul of the equipment. Instructor's manuals, operator's bulletins, visual training aids and diagrams are supplied.

Also, the Sperry Field Service Engineering Dept. is staffed with field engineers who are experienced with aircraft engines and who are qualified to service a customer's equipment when necessary. Each purchase of an engine analyzer is followed up by a field service engineer to give on-the-spot instruction and training to mechanics and engineers.

At Pan American we trained with a mock-up which actually fed a number of different malfunction "problems" onto the scope of the analyzer. This is the best and quickest way to master the use of the device because you are seeing exactly what you will later see in the air, if trouble develops, and you have a trained interpreter with you to speed your learning process. I would advise using a mockup with competent teaching help.

Now—to the actual details of how the analyzer works.

It should be mentioned at once that it has been greatly improved and refined since the first black box was installed on *Constellation* N-88868. The present-day analyzer is smaller, more compact, lighter, and the scope indications are better. The analyzer presently weighs up to 200 pounds, which naturally limits its use in small aircraft. However, it has been used with success in every sort of multi-engined plane from Twin-Beech to *Globemaster*. The analyzer is composed of: 1) a synchronizing generator, 2) a condition switch, 3) a cycle switch, 4) a power supply amplifier, and 5) the indicator or scope.

Each engine served by the analyzer has its own synchronizing generator which is fastened to the auxiliary tachometer drive shaft. This generator creates the voltage which in turn makes a picture of the scope. This voltage is in sync with the engine rotation. It sweeps across the scope horizontally, as a beam of electrons. This horizontal beam is displaced vertically by the firing of the spark plugs, thus forming the "normal pattern." When trouble develops in the system, the beam is distorted into a "trouble pattern."

To test a particular engine, the flight engineer simply switches the pattern of that engine onto the scope by twisting his "condition switch." To test individual cylinders in a given engine, he uses the "cycle switch."

The analyzer has a further refinement. It has two speeds—fast sweep and slow sweep. When operated in slow sweep, the analyzer scope pictures the wave forms for all 18 spark plugs in a given engine, all at the same time. A trained flight engineer, by one glance at this composite picture, can tell if any one of the plugs is malfunctioning.

(Continued on page 40)

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Engine Analyzer

(Continued from page 38)

Having found that one of them looks suspicious, the flight engineer turns from slow sweep to fast sweep. In fast sweep the 18 images vanish. Instead, only *two* wave forms appear—the wave forms caused by the two consecutive plugs in the firing order. These patterns are larger, clearer and more detailed. They are like a magnifying glass for the flight engineer, enabling him to diagnose the trouble with greater certainty than would have been possible with 18 small images.

The analyzer works with equal precision from sea level to 30,000 feet, at temperatures from minus 50°F. to plus 160°F., and at engine speeds from 1,000 to 3,000 rpm. Its components are designed to be accessible for quick overhaul, and only standard commercial-type tubes are used. The analyzer works continuously when the engines are running. The data is always there, available at a glance. Aside from the lock ring on the sine wave synchronizing generator vibrating loose, the analyzers I've used have been free from trouble. Being isolated electrically from the engines, the analyzer does not affect them. No modifications are necessary.

Six years of testing have proved the analyzer to be a sound piece of equipment. It will undoubtedly be used in the future by anyone operating multi-engine equipment who wishes to maintain a tight time schedule or to control maintenance away from home. As everyone knows, maintenance facilities vary from place to place. You may hit a field where you can get a malfunction in the electrical system repaired quickly and well. On the other hand, it is quite possible to sit around for days while an inexperienced mechanic pulls your engine limb from limb and looks fruitlessly for troubles. We at Pan Am have had a bit of experience in this line in some foreign countries. However, if you use an analyzer, you arrive on the ground armed with specific information about your electrical difficulties. You *know* which plug, valve or mag is acting up. There is no guesswork.

As a matter of fact, all Pan American flight engineers use analyzers routinely for "enroute" predictions. Plug changes are a good case in point. Modern high-compression engines damage plugs very rapidly, causing such things as point erosion or copper run-outs. Before we had the analyzer, hunting for defective plugs was like looking for the proverbial needle in a haystack. We had to unload the passengers for an indefinite delay and move the plane away from the ramp to some other test location (since it is against the rules to run up the engines where their blast can annoy the passengers). Then we had to start guessing, pulling out plugs from one cylinder after another. Hunting for bum plugs is like hunting for an important letter. It's always on the very bottom of the file.

With the analyzer, I can tell in the air exactly which plug is giving trouble and what cylinder it's in. I radio this information ahead. The ground crew meets the plane at the ramp with the new plugs in their hands and equipped with the tools to pull the old plugs. We can even advise them whether they will have to install a front-row plug or back-row plug—so they will know if they have to pull the engine cowling off, and can be ready to do so. Often the job can be accomplished during the normal down-time required for a gasoline stop. There is no delay at all. Passengers are impressed by this tight trouble-free schedule even though they know nothing of the black box which made it possible.

For the Record . . .

Since Air Commerce Act was passed in 1926, the scheduled U.S. airlines have flown more than 85 billion passenger-miles; have carried 166 million passengers. Fare in '26 was 12 cents a mile; today, it's 6.1 cents.

Aircraft Industries Assn.

If I were asked to select the analyzer's most important function, I would say its ability to spot a shorted or open secondary. A shorted secondary can mean a mechanical failure. For example, this is what might happen. The engine might swallow a valve, get a top land failure, burn a hole in a piston, split a cylinder head or have a similar violent malfunction. The sparkplug points inside the offending cylinder are usually "peened over" and thus shorted out. If they *both* show a dead short, it's usually a mechanical of some kind. This is the time when the flight engineer has to act quickly (which he can if he is using the analyzer), it may mean only a $500 cylinder replacement job, instead of a $35,000 engine replacement—or a fire to put out. Mechanical troubles have a habit of going from bad to worse in a hurry. An engine fire, for example, must be caught in the first 11 seconds or your chances of not getting it out at all are good. In 11 seconds the magnesium starts to burn, and the engine usually burns out of the wing.

The uses of the analyzer are growing all the time, but it may be illuminating to detail a few old standbys. The analyzer picks up "out-of-time" magnetos at cruising altitude. We usually cruise wide open at high altitude because, as you know, the rarified air does not permit the engine to develop its full sea-level power and even when wide open is not under too great a strain. However, under such conditions, any loss in power is very noticeable. By using the analyzer we can tell at once if the power loss is due to mis-timing, and can order corrective maintenance at our next turn-around point.

Many times the analyzer can detect troubles which the flight engineer can remedy in flight. A high-resistance pattern, caused by carboned plugs, is an example. When you read such a high-resistance pattern on your analyzer, you can move your mixture control to full rich, or use water or alcohol injection. Often this cleans up your plugs and causes the trouble pattern to fade from the scope. You regain full power, cool down the engine, and save ground maintenance later. Also, if gas consumption is critical, you keep your cruise-control as efficient as possible.

Sometimes it happens that an engine will have a full magneto failure in flight. If you know *which* mag it is, you can safely switch from "both" to the good mag and continue onward at reduced power. However, testing mags with the on-off-both switch when the engine is turning up to power, is not a delicate thing. It causes a severe jerk. If the engine has an incipient structural weakness, that jerk can set off a chain reaction which leads to grief. By using the analyzer, it is possible to determine which mag is defective, and the switch may be turned from "both" to that mag without danger, and the other mag is taken out of commission.

The big weakness in our system is the fact that very often a flight engineer runs across a new trouble pattern which he writes up in his log, and then, due to not taking the same plane on his next trip, never hears about it again. He knows he had trouble. He knows what that trouble looked like on his scope, but due to lack of follow-through between him and the ground crew which locates and fixes the trouble, he misses out on finding the real nature of the trouble. If a flight engineer could get a copy of the maintenance log after the fix is made, he could quickly expand his knowledge of trouble patterns and their causes. This information could then be made available to the other engineers.

Uses for the analyzer expand week by week. Portable analyzers are being used by airlines for plug-in testing when a plane is wired for an analyzer, but has no permanent model installed. Accessory shops, maintenance contractors, airframe and engine manufacturers and overhaul shops are also putting the portable analyzer to good use. It has been used on *Constellations*, *Stratocruisers* DC-6B's, Convairs, Martins, DC-3's, *Lodestars* and others. MATS is a big customer. Private companies, like Bethlehem Steel, are still another.

In addition to pinpointing electrical malfunction, the analyzer can be used to ferret out vibration disturbances. By attaching vibration pickups on each cylinder, the flight engineer can detect detonation, improper valve operation, piston failure and other conditions which cause abnormal piston vibration.

My company estimated, on the basis of the guinea pig *Constellation* N88868, that the analyzer was saving about $9,000 per year per *Constellation*. On the *Stratocruisers* then in use, it was estimated the analyzer would save $20,000 per year per plane. These are substantial savings. On a big fleet over a period of time, they mount up astronomically.

There is no way to estimate the importance of passenger good will resulting from fast, tight trouble-free schedules. However, it is well known that aviation must stand or fall on the opinions of those who ride airplanes. There is no doubt that the little black box that Pan American tried out first in 1946 has contributed greatly—and will continue to contribute—to aviation progress.

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Automatic Computers

(Continued from page 16)

sentially the same functions as the Type A-1 GPI and additionally provides several other functions. It is designed to be used with an airborne search radar such as the AN/APS-10. When used in this manner, the combination provides a radar position-fixing system and a method of wind determination by memory point tracking of radar reference points. The Computer Unit has provision for computation of Direction to Destination, Course being made good, and True Heading for the aircraft to fly to arrive at the selected destination. Time to go until arrival at the referenced destination is also computed. In one mode of operation a Pilot's Direction Indicator is activated.

The computer unit is a compact assembly 11 x 16 x 19 inches and weighs approximately 48 pounds. It is shown in *Figure 8* along with the True Airspeed Meter, one of the inputs to the computer.

Of special note is the mechanical design of this computer. It consists of several functional sub-assemblies, each being removable from the computer unit frame. In addition to the six removable sub-assemblies in the front of the unit, there are several removable from the back. Since these sub-assemblies merely plug in, they can be easily removed and a patch cable can be inserted to facilitate servicing. A metal card is used for mounting of tubes and parts because of its heat conduction characteristics. An added advantage is its shielding effect. Glass bead inserts with feed-through terminals are used extensively.

This computer uses 85 vacuum tubes, 75 of which are subminiature types. It is not considered as conclusive evidence of the superiority of subminiature tubes, but it is encouraging to note that one of these computers has had almost 1,000 hours operation with only one tube failure (a miniature type).

Almost all of the transformers in this computer are of special design. They are designed to run at high temperatures and are sealed in aluminum cans filled with inert gas. No difficulty has been experienced with these transformers.

Referring again to *Figure 8*, in the lower center of the panel is a servoed-indication of true airspeed. In the upper left-hand corner is a servoed-indication of compass heading from the gyrosyn compass input. When the adjacent "Variation" dial is manually set for correct local magnetic variation, the case (and stator winding) of the Synchro from which the "Compass" indication is driven is rotated so that the "Compass" indication becomes true heading.

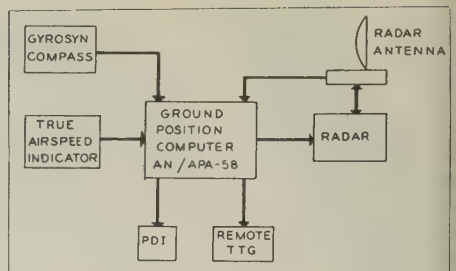


FIG. 7 AN/APA-58

Plane Position is manually set at the start of the navigation problem and at anytime thereafter that a more reliable position determination can be obtained by any means. In order to do radar position correction, it is first necessary to set the identification counters to the latitude and longitude of a known radar reference point within the range of the radar, but not more than 100 miles away. Also, essential to correct measurement of position is the setting of aircraft altitude on the counters in the lower left of the computer panel. When these things are done, the range circle and azimuth mark, usually referred to as cross-hairs, appearing on the radar indicator should intersect on the radar reference point if the Plane Position counters are correct. If the cross-hairs do not lie on the proper point, the Plane Position counters can be manually turned until the cross-hairs are moved to coincide with the reference point.

Once set correctly, the Plane Position counters will continue to indicate the position of the aircraft except for errors in the input data. The major source of error is the knowledge of wind since it is continually changing in an unpredictable manner. If north-south and east-west wind components were set in initially based on meteorological predictions, it may be that the error due to this cause is

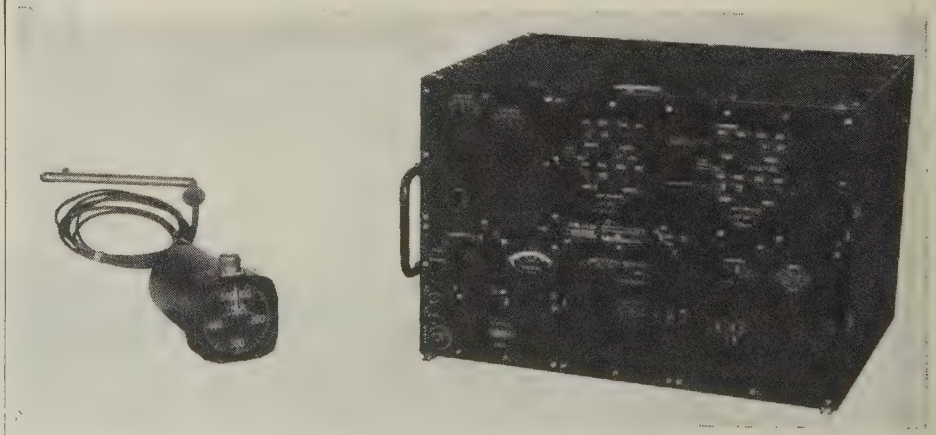


FIG. 8—*Computer unit of the AN/APS-10 is compact assembly weighing about 48 pounds*

not large. In any case, if at any time a reliable setting of Plane Position is made and at any later time as a result of a radar fix it is noted that an error in position has developed, a position correction should be made, followed by a Wind Tracking operation. This is done by turning the Tracking clock to 10 minutes, observing the drift of the cross-hairs from the radar reference point and repositioning the cross-hairs at a suitable time within the 10 minutes while the radar target is still in good view. The correct wind (assuming all error is due to wind error) will be computed, indicated and fed to the integrators.

The Function Switch has three operating positions, "Navigate," "Course" and "P.D.I." All of the operations so far described are done with the switch in the "Navigate" position. When turned to "Course," functions

Plane Views

A major aircraft manufacturer purchases 50,000 tons of materials each year, an amount roughly equal to the dead weight of the Navy carrier Midway, *one of the largest in the world.*

•

To overcome the effects of air friction at high speeds, a refrigerating system in a modern jet fighter must have a freezing capacity equal to 176,000 ice cubes a day!

Aircraft Industries Assn.

having to do with the Identification point are inoperative and an azimuth mark signal (representing the ground-track angle of the aircraft) is generated for the radar indicator. In the "P.D.I." position, no markers are fed to the radar. Instead, the heading to fly to reach a destination set on the "Identification" counters is computed and displayed on the dial in the lower center of the computer panel. Also an error signal is generated and fed to the vertical needle of the Indicator ID-48/ARN. The "Time-To-Go" Indicator is actuated during the "P.D.I." function.

Figure 9 is a simplified functional diagram showing the computational arrangement when the Function switch is in the "Navigate" position. The true airspeed input is obtained from a special miniature synchro take-off in the True air speed Meter ID-205 (XA)/APA-58. A position servo operating from the true airspeed synchro drives a potentiometer across which a 400-cycle scale voltage appears. The output from the potentiometer is proportional to airspeed and is fed through a driver amplifier to the rotor of a synchro resolver.

The other input to the airspeed resolver is true heading. This is obtained in the following manner. A transmitter synchro is located in the magetic compass. A follow-up synchro in the Compass sub-assembly of the Computer Unit generates an error signal when not aligned with the take-off synchro and this sig-

(Continued on page 44)

Central Airlines, Inc. (Texas) installed Scott FIXED OXYGEN EQUIPMENT

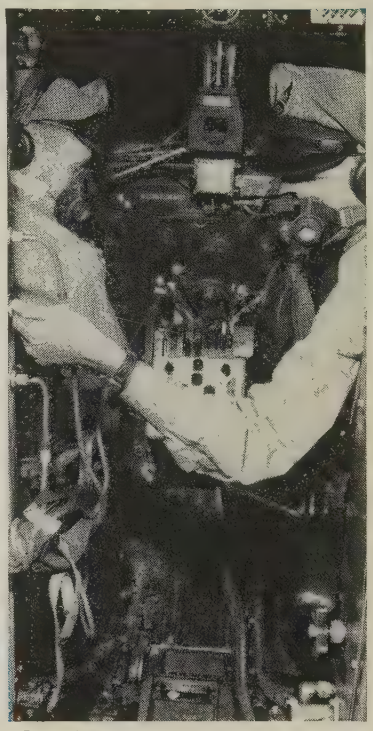
For the Safety and Comfort of Passengers and Crews

THE PROBLEM Central Airlines, operating a fleet of DC-3's at altitudes not normally requiring oxygen, was faced with the necessity of providing oxygen for crews and passengers in order to use alternate airports.

THE SOLUTION The Scott 8500 Oxygen System was recommended by Air Associates, Dallas, to J. C. Daniels, Central Purchasing Agent, because of the unusually low cost, easy installation and quick servicing.

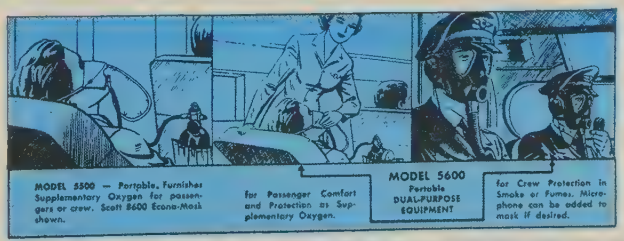
The installations were planned by E. E. McCory, Director of Maintenance. The oxygen cylinder was mounted in an accessible cargo compartment. The regulator and gauges are behind the co-pilot with three outlets to serve the pilot, co-pilot and jump-seat passenger. A line from the regulator supplies four passengers. These adequate yet simple installations were made at the modest cost of $415.00 per plane, including labor.

Write for literature on this adaptable equipment.



Crew installation including provision for jump-seat occupant. All crew using A-8-B Rubber Masks.

Four-passenger installation. Scott Disposable Masks being used.


MODEL 5500 — Portable. Furnishes Supplementary Oxygen for passengers or crew. Scott 8600 Econo-Mask shown.
for Passenger Comfort and Protection as Supplementary Oxygen.
MODEL 5600 Portable DUAL-PURPOSE EQUIPMENT
for Crew Protection in Smoke or Fumes. Microphone can be added to mask if desired.

Scott

SCOTT AVIATION CORP.

226 ERIE STREET LANCASTER, NEW YORK

Export: Southern Oxygen Co., 157 Chambers Street, New York 7, N. Y.

Automatic Computers

(Continued from page 43)

nal is fed through a servo amplifier to a low-inertia two-phase motor and a gear reduction box to rotate the follow-up synchro to a null position. Magnetic variation is introduced by rotating the case of the follow-up synchro. The output of this servo system is true heading and is mechanically coupled to the airspeed resolver. The outputs of the airspeed resolver are two voltages, north-south component of airspeed and east-west component of airspeed. These voltages are inputs to the latitude and longitude integrator circuits respectively.

In series with each of the output windings of the airspeed resolver is a voltage derived from the corresponding wind potentiometer. For example, the latitude integration circuit has as one input a voltage which is the sum of the north-south component of airspeed and the north-south component of wind. Therefore, if the wind setting is correct in the north-south channel, one input to the latitude channel is north-south ground speed. By use of a unique rate servo, which will be described later, the latitude counters are continuously driven to maintain correct indication of latitude within the accuracy of the various inputs. A similar integration takes place in the longitude channel, with the exception that the east-west rate must be modified by the secant of latitude.

Since one of the objectives of this computer design is to allow radar position fixing, it is necessary to generate a range mark and an azimuth mark based on the range and azimuth of some identification point relative to the indicated position of the aircraft. This is accomplished by setting the Identification counters to the latitude and longitude of the reference point. A differential between Plane Position and Identification counters drives a range potentiometer in each of the channels. It should be noted that the computation of range in the longitude channel is a cosine function of latitude, *i.e.*, the higher the latitude the lower the value of range represented by a given number of degrees longitude. The range resolver circuit provides as an output the ground range to the Identification point. In order for this to be usable for presentation on the radar indicator, it must be converted to slant range. This is done in a triangle solver into which is inserted the altitude of the aircraft. The altitude setting on the computer can be made based on other sources of altitude data, but may be made by switching to a range mark signal which is a function of altitude only. Then, when it is adjusted so that the range mark coincides with the ground return circle on the radar indicator, the correct altitude has been reached.

The range Mark Generator accepts a synchronizing signal from the radar in order to generate a range mark which will appear at the proper point in range on the radar indicator.

The other signal supplied to the radar set is the azimuth mark representing the direction to the Identification point. The condition necessary for generation of the azimuth mark is that the true heading plus the angle of the radar antenna with respect to the true heading must equal the angle with respect to true north of the Identification point.

When operating in the "Navigate" mode, it is possible to determine the correct wind by memory-point tracking of a radar target. In order to determine wind by this method, the cross-hairs are set on a suitable radar reference point. Any clearly definable radar echo may be used even though its position may not be known. The 10-minute mechanical timing unit is turned on. If the correct wind has been set into the Wind Set dials, then the cross-hairs should move synchronously with the radar reference point. If the wind values are wrong, the cross-hairs will drift off. At any time during the tracking operation the tracking control or "Joy Stick" can be used to control the positioning of the cross-hairs and thereby correct the wind setting automatically. It is simple and easy to operate.

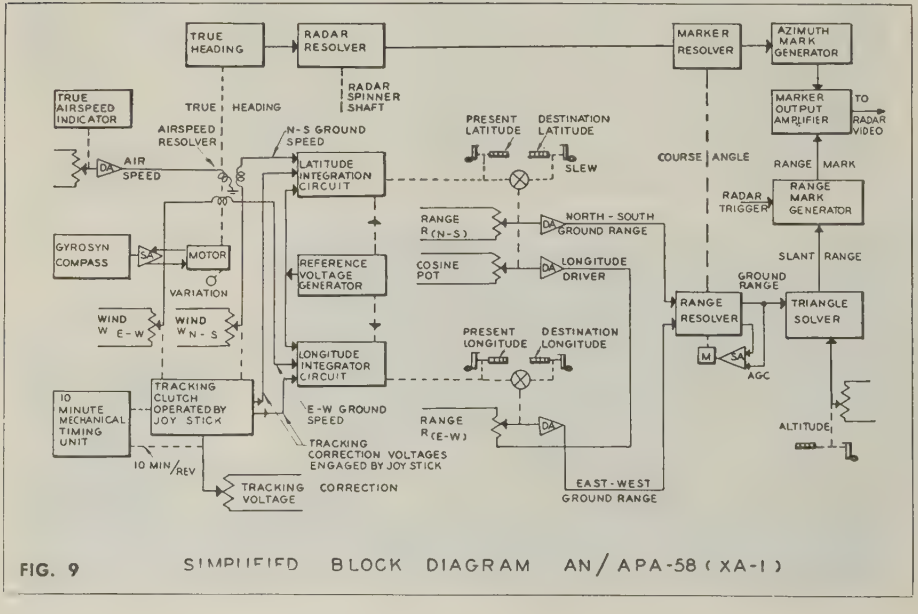
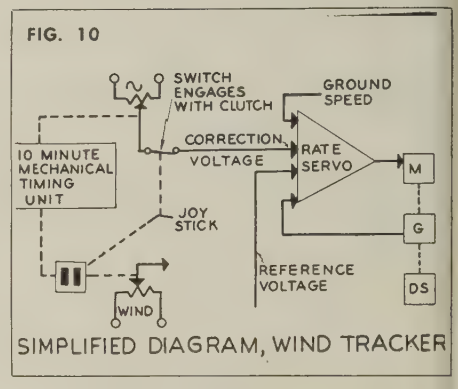


FIG. 9 SIMPLIFIED BLOCK DIAGRAM AN/APA-58(XA-1)

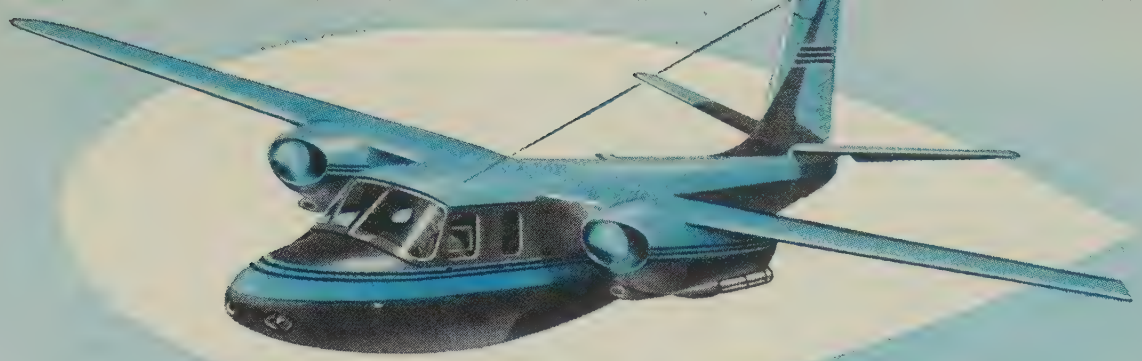
The wind tracker is illustrated with reference to one coordinate in *Figure 10.* A constant speed timing unit drives the Correction Potentiometer so that the zero correction voltage is available at the start of the period and the maximum at the end. The "Joy Stick" is not operated until it is observed that the cross-hairs have departed from the radar reference point. At this time the "Joy Stick" is operated, clutching in the constant speed drive to the Wind potentiometer, and connecting the correction voltages to the input of the integrator rate servo. The position counters are thereby driven at a higher or lower rate than normally, thus causing the range to the identification point to be corrected.



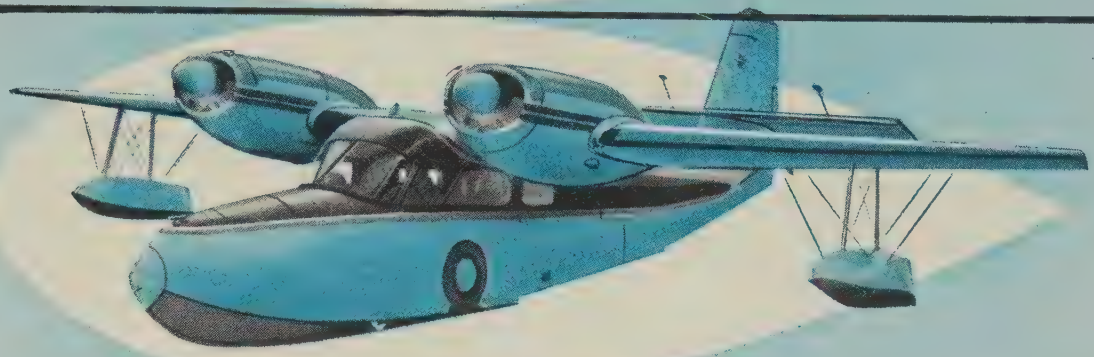
The scale factors chosen are such that the proper change in the setting of the wind potentiometer takes place in the same correction time.

The integrator circuit has certain novel features. In order to avoid the problem of passing through zero speed and the difficulty of obtaining uniform speed characteristics in both directions of rotation, it was decided to design a circuit in which zero is, in effect, 4,000 rpm. An induction motor running at 12,000 rpm geared to a reference generator running at 4,000 rpm develops a reference voltage. This voltage is fed to the input of the integrator servo amplifier. The servo amplifier drives a variable speed motor coupled to a generator from which a voltage is fed back to the input of the integrator servo to balance the reference voltage. The integrator generator is mechanically coupled to a differential synchro which receives a signal from a transmitter synchro coupled to the reference generator. The operating speed of the transmitter synchro is 48 rpm and the differential synchro varies from 12 to 84 rpm as a function of ground speed in each coordinate. The output from the differential synchro goes to a receiver synchro, servo amplifier and servo motor which mechanically drives through a gear train the receiver synchro over the speed range of 0 ± 36 rpm. The aircraft position counters are also driven from the same servo motor.

Thus, the pilot-navigator of today's jet fighter is heir to an Air Force development which eliminates manual computations for solution of navigation problems and offers instead automaticity to the solution of such problems.



Aero-Commander. Seats 6. Powered by two 260-h.p. Lycoming air-cooled, geared engines.



Grumman Widgeon Conversion. Amphibious flying "office" featuring 260-h.p. air-cooled, geared engines by Lycoming.

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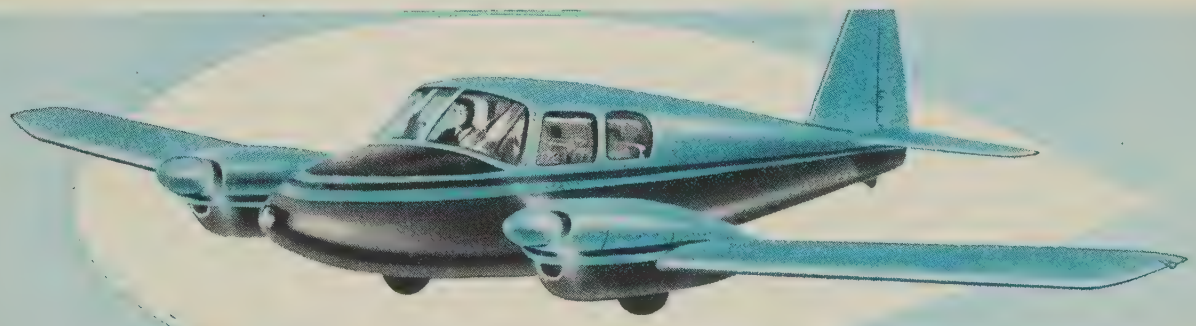


Piper Apache. Seats 4. Dependably powered by two 150-h.p. air-cooled Lycoming engines.

Riley Twin Navion Conversion. 4-place executive plane powered by two 150-h.p. air-cooled Lycoming engines.

Company 'Copter

(Continued from page 17)

knew we would be pioneering a new method of travel for a corporate management group. The helicopter had proved itself commercially feasible more than a decade ago; its versatility was demonstrated over and over again during World War II and even more dramatically in Korea. We were soon to learn, however, that Rockwell's helicopter was the first ever used by an American corporation exclusively for executive and staff transportation. This does not mean that business concerns have shunned the helicopter. Helicopters are used to patrol pipe lines; they are used to direct commercial fishing fleets. But on the basis of authoritative information, ours is the first helicopter owned and operated for executive transportation.

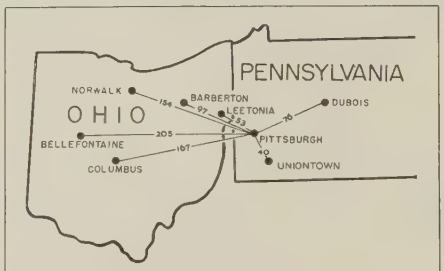
Although our investigations leading to the purchase of a helicopter had been businesslike, the revelation that we were about to do something new caused us to re-examine our earlier decision. We asked ourselves, "why did we buy a helicopter?"—the second time even more critically than the first. We also attempted to determine why no other company had purchased a helicopter for executive and staff transportation. We discovered we had a problem somewhat different from that of most manufacturing concerns, and we again concluded that the helicopter best answered our problem.

One basic consideration which led us to a helicopter is the corporate makeup of Rockwell Manufacturing Company. Our Company consists of 17 separate divisions—actually 17 small and medium-sized businesses more or less autonomous in their operations but dependent upon our centralized executive office in Pittsburgh for certain basic management functions such as sales, and for numerous specialized services which can be supported by a large company but which cannot be afforded by small and medium-sized concerns. Coordinating the activities of a corporation so constituted is perhaps the primary function of our management. The result is that members of our management staff, together with our staff or production, sales and administrative specialists, are in a constant state of travel. This in itself was not necessarily a cause for action on our part; we were activated only when we realized how much time was spent in non-productive travel —the actual going and returning to our many plant sites, rather than the time spent at each plant.

We began to analyze this problem by placing our plants in two categories; first, those in communities serviced adequately by commercial transportation, either air or rail; second, those in communities not serviced adequately on a commercial basis. In the first group were plants located in such cities as Brooklyn, East Chicago, Tulsa, Milwaukee and Oakland, Calif. The second group consisted principally of seven plants in seven communities almost within a 200-mile radius of our main office in Pittsburgh.

Further study disclosed that an overwhelming proportion of non-productive travel time was accumulated in traveling to and from plants in the second category. We found, for example, that our executives were able to visit our East Chicago plant in less time than would be required to visit our plant at Barberton, Ohio, even though the mileage to East Chicago is three times as great. In other cases, we realized that a one-day visit to a plant barely more than 100 miles from Pittsburgh necessitated spending the better part of a day on a train, or as much as four hours by auto, each way.

On the basis of this examination, we determined that our principal problem from a transportation standpoint was bettering presently available facilities to seven plant cities in Ohio and Pennsylvania. They are: Dubois, Pa., 100 miles from Pittsburgh; Uniontown, Pa., 30 miles; Norwalk, Ohio, 191 miles; Barberton, Ohio, 130 miles; Leetonia, Ohio, 60 miles; Columbus, Ohio, 185 miles; and Bellefontaine, Ohio, 248 miles. These distances are from Pittsburgh, and with the exception of our plant at Dubois, Pa., the distances from one Ohio plant to another are generally considerably less than from Pittsburgh.



MAP *indicates seven plant cities to which 'copter flies out of Pittsburgh*

Once having defined our basic problem, the solution lay in finding a faster means of transportation than we had been using in the past—a form to replace commercial air, rail, bus and private auto travel. The answer appeared to be a form of air travel and the obvious seemed to be purchasing a standard twin-engine plane that would allow three or four executives and staff members to travel simultaneously.

We went deeper into the subject—preparing among other items, a study of landing facilities at the seven plant cities which would form the regular itinerary. We learned that several small communities were dependent upon county airport facilities for landing a plane—a factor which necessitated auto trips to our plants ranging from 30 minutes to an hour duration. In the case of our plant at Columbus, Ohio, the drive from airport to final destination takes well over an hour. And the trip from our own main office in Pittsburgh to the nearest airport averages between 30 and 45 minutes. We decided that having our own private plane still would not eliminate the basic defects of commercial transportation and travel by private car: the accumulation of non-productive travel time on the part of our executive staff.

We became convinced that what we really required was a door-to-door taxi service from our main office in a moderately heavily populated section in the eastern part of Pittsburgh to our seven plants in Pennsylvania and Ohio; and taxi service, too, from one plant to another, since we foresaw the possibility that proper transportation would enable us to call on two or three plants in a single day.

The helicopter appeared to be an ideal solution, and since no one in our organization had had prior experience in helicopter operation, we made an intensive study of the various kinds of craft available to us. Our thoughts turned in this direction at about the same time Sikorsky's S-55 was first in the news because of its dramatic battlefield rescue operations in Korea. Naturally, we were interested in knowing the characteristics of the S-55 in a more pedestrian atmosphere. Here were some of the specific requirements we wanted to satisfy:

1. Transportation for at least four persons, and preferably five or six in addition to a pilot.
2. Space and payload capacity for up to 1,000 pounds of cargo (this provision was in anticipation of emergency deliveries either among our various plants or to a customer within the helicopter's normal range).
3. Sufficient range to cover plant cities.
4. Ability to take off and land in built-up areas.
5. Economical operation.
6. Maximum safety features.

The S-55 can transport eight persons, or a net payload of 1500 pounds of cargo, in addition to crew, for a distance of 100 miles with a conservative gross weight of 6,835 pounds. This seemed entirely adequate for our purposes, since we did not foresee that we would have the need to carry eight passengers on a single trip, a factor which, of course, would extend the range of the ship enough to meet our needs. The S-55's cruising speed of 90 mph seemed entirely adequate for our purposes, particularly in view of the fact that the helicopter can be landed within walking distances of our destinations.

Having settled on an S-55, we placed our order for delivery almost a year later. Our next step was to employ a skilled pilot who not only would be responsible for the helicopter's operations but who would also make all arrangements at our plants for taking off, landing and parking. The pilot was also responsible for establishing flight patterns for approaching and leaving plants and for establishing best courses to, from and between our outlying plants and our main office. Our choice for this job was Joe McClure, a veteran of 10 years of dependable service with Eastern Air Lines who reported for his new assignment about six months ahead of the date of anticipated delivery.

Mr. McClure's first task was contacting interested state, county and municipal officials as well as representatives of the Civil Aero-

nautics Authority, to discuss in minute detail our plans, including take-off and landing approaches and flight courses. He received the encouragement and cooperation of all concerned.

This activity was followed by preparing landing and take-off facilities at our main office in Pittsburgh and at various of our outlying plants. The most extensive improvements had to be made in Pittsburgh. We expanded our parking lot and made minor improvements to an existing little-used building to serve as a hangar. Improvements at other plants were relatively minor and involved such items as removing trees to facilitate safe landings and take-offs and expanding parking lots by trucking in gravel.

Rockwell's helicopter now has been in service for several months. Our executive staff has been enthusiastic in accepting this new equipment as a "management tool" much the same as they accept a new caculating machine or a new communication system.

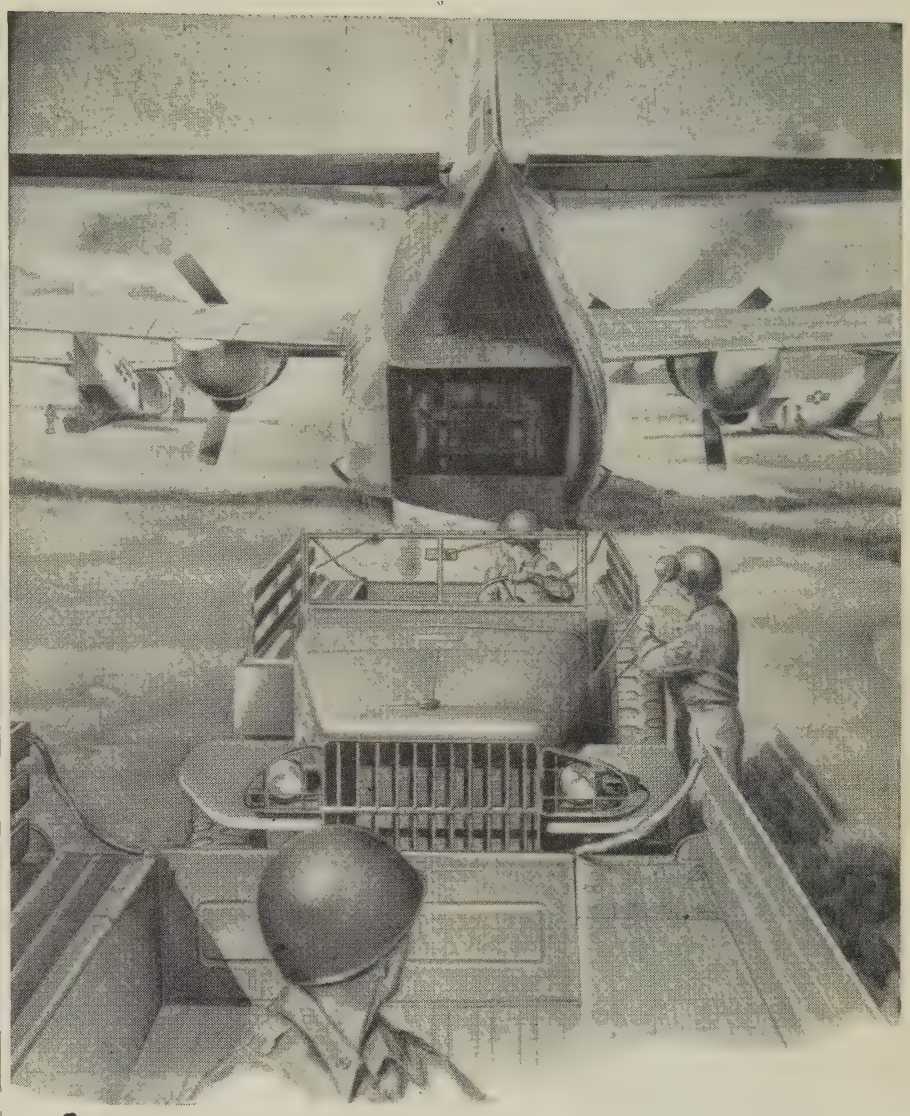
In addition, the helicopter has produced certain desirable "fringe" benefits that have helped build good-will among our neighbors and our customers. One of the first assignments carried out by Pilot McClure took place during Pennsylvania Week, when Pennsylvania's Governor Fine visited Pittsburgh. Our helicopter landed in the rear of Pittsburgh's Golden Triangle, picked up a reception committee that included Mayor Lawrence, and then flew the committee to the airport to meet the Governor, who flew downtown by helicopter with the party. Needless to say, Rockwell's 'copter was much in the local news that day.

On another occasion, the helicopter went to Chicago during the annual convention of the American Petroleum Institute, an organization whose membership numbers many of our customers for valves and related equipment. We arranged trips from downtown Chicago to our Edwards Valve Plant in East Chicago, and again, we believe, the helicopter added considerably to what otherwise would have been a prosaic plant tour.

But it is the routine day-to-day travel which has convinced us that a helicopter is our best bet. Visits to Pennsylvania and Ohio plants are now more frequent than ever before, and they're being made at considerably less cost than formerly. Non-productive travel time has been reduced to an absolute minimum for an organization such as ours. We believe we have selected the one "best" method for our own specialized requirements.

Company Aircraft

Businessmen last year flew in their 11,000 company-owned aircraft almost as many plane-miles as entire fleet of scheduled domestic airlines. In 1952, business-aircraft logged over 422 million plane-miles and flew over 3.25 million hours. These aircraft represent an investment of $175 million, and an expenditure of from $30 to $50 million annually in parts, etc.



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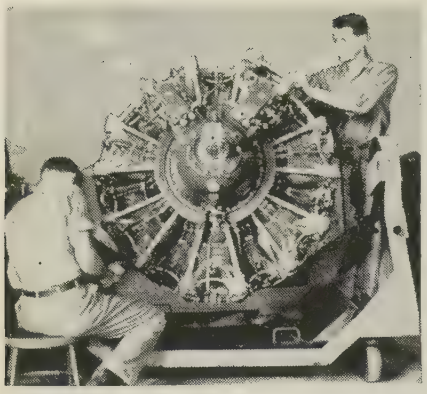

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Common System

(Continued from page 19)

with a rim about 30 feet in diameter. The whole structure is usually less than 20 feet high.

Omnirange signals are transmitted in the VHF part of the radio spectrum, between 108 and 118 mc, just above the frequencies used for FM radio broadcasting. These frequencies are virtually free of static interference, even in heavy thunderstorms.

These very high frequencies have another unusual characteristic. Omnirange signals, like television and FM transmission, can be received only within "line of sight." Unlike lower frequency signals, VHF radio waves do not follow the curvature of the earth but travel straight out into space.

In the case of television and FM radio, receiving antennas must be placed on high towers for distant reception. But aircraft, flying well above the earth, are not handicapped in this way. Generally, the reception distance is 30 miles when the plane is at an altitude of 500 feet; 100 miles or more at 5,000 feet. Maximum reception is about 200 miles at 20,000 feet, and indications are that omnirange navigation is practical to at least 40,000 feet.

A VOR Receiver in the aircraft has a dial for tuning in the VHF Omnirange desired, like tuning in a station on a home radio. An Omni-Bearing Selector, graduated like a compass dial from 0° to 360°, can be rotated to any bearing desired. Finally, there is a Course Line Deviation Indicator, an instrument having a vertical needle, pivoted at the top, which moves left and right, and an indicator which tells the pilot whether the bearing is "*To*" or "*From*" the VOR to which he is tuned.

To fly to any VHF Omnirange within reception distance, the pilot tunes in the station and turns the Omni-Bearing Selector until the Deviation Indicator needle centers, and the *To-From* Indicator says "*To*". Flying the aircraft on the approximate heading shown on the Omni-Bearing Selector, the pilot merely keeps the Deviation Indicator needle centered. If the needle moves right, he turns slightly right to correct his heading. If it moves to the left, he turns left. Corrections are always made by "flying toward the needle."

As mentioned earlier, there is an infinite number of course lines or radials to or from a VHF Omnirange. Therefore, whether a pilot is on or off an airway, he has specific information at all times of his direction in relation to the VOR; he is never confused about his quadrant.

When the aircraft settles down on a heading which keeps the needle centered, the pilot may notice that there is a difference of several degrees between the reading on his bearing selector and the magnetic heading shown on his compass. This means that there is a crosswind and that his aircraft is "crabbed" into the wind to compensate for it. By "flying the needle," wind drift is taken care of automatically, and the aircraft flies a straight line to or from the VOR.

To understand VHF Omnirange flying, it is important to keep in mind the difference between magnetic compass and VOR information. The compass always shows the way the aircraft is pointing at a given moment. The Omni-Bearing Selector, on the other hand, shows the bearing of the VOR from the aircraft.

The way in which the aircraft is pointing, or heading, has no effect on VOR bearing indications.

This can be illustrated by flying a tight circle some distance from a VHF Omnirange. During the circle, the compass will turn through 360°. The needle of the Deviation Indicator, on the other hand, will remain almost vertical, since the aircraft has remained in almost the same spot in relation to the VOR.

Omnirange radials can be regarded as fixed lines in space or fixed lines drawn on the ground. Nothing changes them—wind drift, aircraft heading, and altitude have no effect on them. A given radial is effectively a straight line to or from the omnirange.

When an aircraft passes over a VOR, the Deviation Indicator needle fluctuates violently for a few seconds and then settles down near the center. Simultaneously, the "*To-From*" Indicator, which previously indicated "*To*", changes to "*From*". The VOR, instead of being ahead of the aircraft, is now directly behind. The bearing of the VOR in relation to the aircraft, has been reversed by half a circle or 180°. The instruments have faithfully reflected this situation and now show that the same bearing which previously was "*To*" the VOR is now "*From*" it. If the pilot wishes to continue on his original course, he merely keeps on "flying the needle."

In turning the Omni-Bearing Selector through its 360°, the Deviation Indicator needle will center twice, once at the bearing "*To*" the station and again at the bearing "*From*" the station, 180° apart. If you wish to fly "*To*" the station, you will obviously center the needle with the indicator showing "*To*". If flying away from the station, you will use the "*From*" bearing.

After the pilot has settled down to "fly the needle," it is important that he check the bearing shown on his Omni-Bearing Selector with his compass heading. These should be in general agreement. However, if the compass heading and the VOR bearing are about 180° apart, it means that the "sensing" is reversed, and the aircraft is heading in the opposite direction to the course. To correct the situation, the pilot must make a 180° turn and continue "flying the needle."

As an example, a pilot who has no idea of his general location tunes in a VHF Omnirange. The needle centers at 270° with a "*To*" indication and 90° with the indicator at "*From*". The VOR clearly is to the west of the aircraft. The pilot wishes to fly to the station, so he selects the 270° bearing and the "*To*" indication. The needle is centered and he is on his way—or so he thinks.

Eventually, as the needle moves a little to one side, our pilot flies toward it to correct.

(Continued on page 50)

External Fuel Loading

(Continued from page 25)

preliminary investigation was substantiated by actual "shake" tests conducted by A. M. Kaplan, Chief Structures Engineer of Aircraft Conversion, in the presence of CAA flutter and vibration engineers from the 6th Regional Engineering Office.

Improve Flight Characteristics

Preliminary calculations by J. G. Brown, Chief Engineer of Aircraft Conversion Engineering, indicated that the wing-tip installation could be expected to improve the airplane's aerodynamic characteristics. It was expected that, mounted at the wing tips, the tanks would provide a beneficial end-plate effect to allow the same or reduced drag at cruise speeds and to improve lateral stability and control at speeds near the stall.

Exhaustive flight tests with the converted B-25 subsequent to the tank installation have substantiated the preliminary design expectations in all respects. A noticeable increase in aileron effectiveness was noted, especially at slow speeds. There was a marked improvement in lateral stability and better control could be maintained during landing. Flight tests carried out in turbulent air conditions showed that no torsional movement relative to tank and wing was observable. While no accurate speed data was available for the airplane previous to the installation of the tip tanks, it was estimated that an increase in cruising speed of 4% had been effected.

It was also noted that the down bending due to tip-tank loads reduced the flight loads, and this indicated it would be possible under these conditions to increase the ability of the wing to carry loads without drastically increasing the bending material of the wing.

Also, with the external tanks located almost at the CG of the airplane, there is little effect upon CG travel as fuel is consumed, consequently trim correction is minimized. Externally stored fuel simplifies maintenance and servicing and increases safety.

Minimum Rework

A minimum of rework was necessary to accommodate the tanks. The major modification of wing structure was due to the landing loads and bending. Schlumberger specified that the design must provide structural strength to permit landing with full fuel in the tip tanks—1300 pounds per tip, and wing strengthening was carried out accordingly.

The main spar web was reinforced three feet inboard from each wing tip—the lower beam caps for 130 in. inboard, and the upper beam caps for 105 in. inboard. The cap reinforcements were tapered laminated 24S-T doublers through existing rivet patterns. Wing panels were increased in thickness in some areas from .032 to .040. A tapered .032 24S-T doubler 50 in. wide chordwise and 24 in. spanwise was added to the wing tip to build up shear area. Rivet sizes in the doubler area were increased from AD5 to AD6's.

The modified Pastushin tank is attached to each wing tip by three close tolerance bolts. One bolt in the forward fitting takes torsion loads and the two bolts through the aft fitting take the bending loads. A fairing fillets the space between the tank and the wing. The wing-to-tank joint is designed so that the tank may be removed on the ground without further rework being necessary. Wires from the navigation light in the outboard side of each tank are conveyed to the airplane's electrical system through a 528-0 tube running through the tank. A submerged Thompson DC-6 type pump transfers fuel from wing-tip tanks to the main tanks at the rate of 1200 gallons per hour. (The converted B-25 consumes fuel at the rate of 110 gallons per hour and cruises at 230 mph at 55% throttle. With 1,733 gallons of fuel aboard the range is 3,625 miles without reserve.)

Tip Tank Trend

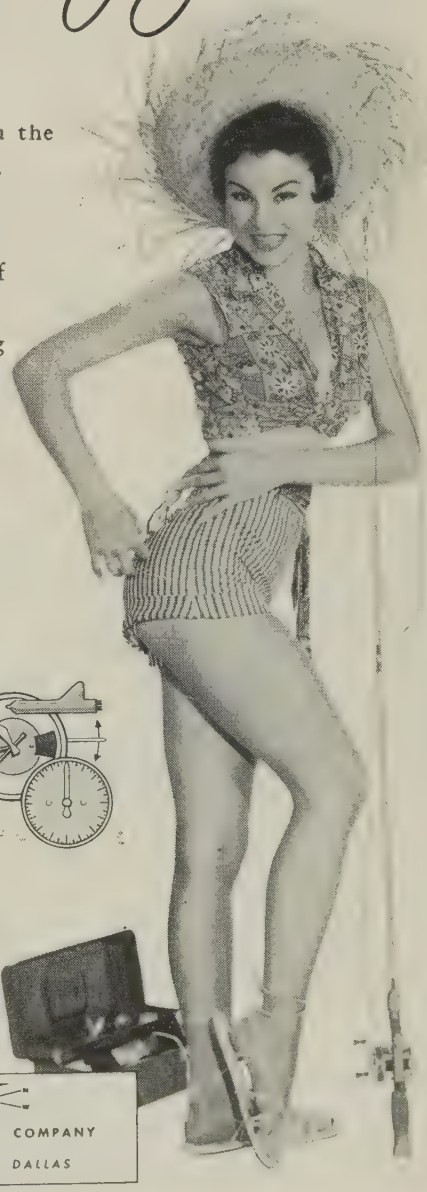
This installation of wing-tip tanks is in line with a trend becoming more and more marked among civilian aircraft. The new Twin-Cessna carries its entire 100-gallon fuel load in two 50-gallon tip tanks.

What began as a development of military combat necessity now proves to be a matter of real significance to civilian flying, increasing safety and actually improving in-flight performances.

Facts and Figures!..

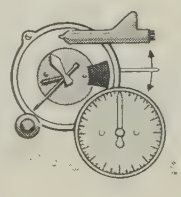
Figure:

Now, cloud-clobbering classmates, gather 'round and we'll show you the difference between a lure and allure. Obviously, Rosemary Gowen (21, 118 lbs., 5'7", brown hair and eyes) has both. She has hooked herself with one, while reserving the other to angle for, say, a bass-voiced flying fish at the beautiful concrete beach of Southwest Airmotive in Dallas.



Fact:

For hundreds of pilots throughout the Western Hemisphere, there's allure aplenty in the quality, dependability and reasonable prices of the Southwest Airmotive Instrument Shop. Recently expanded and newly-equipped, this shop can do everything from setting a clock to custom-building a complete executive aircraft panel. Write for details and prices.



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Common System

(Continued from page 48)

A strange thing happens. The farther he flies toward the needle, the farther the needle moves away from the center. He has forgotten his compass and is flying east, away from the VOR, instead of westward toward it. By making a 180° turn and heading west, the pilot is back on his course.

This reversed sensing is unlikely to occur if the pilot has even the most general idea of his location in relation to the VOR. It will never occur if the pilot makes a habit of checking his bearing selector indication against his compass heading.

Most omniranges, like most four-course ranges, are equipped with voice facilities. A pilot tuned to the VOR can hear traffic control instructions and weather broadcasts as well as the three-letter Morse code identification signal. On some VOR's, this code signal is supplemented by voice identification which says, for example, "Ft. Worth Omni" at frequent intervals.

Visual-Aural VHF Radio Range

Prior to installation of VHF Omniranges, a few airways were equipped with another type of very high frequency range called the Visual-Aural VHF Radio Range (VAR). Eventually, all VAR's will be converted to VOR's.

Like LF/MF four-course radio ranges, VAR's have only four courses. Two of the courses, usually beamed along an airway, can be flown visually with a right-left needle. The other two courses are flown by listening to the same dash-dot sounds heard on LF/MF ranges.

Fan and Z Markers

So far, we have discussed the radio ranges which tell a pilot where to fly. But he needs to know more than this—he needs to know how far he is along his course. A radio range tells a pilot that he is on a certain course line, or bearing, in relation to the range. But it provides no information as to how much progress has been made along that line.

Fan Markers along the airways are like road signs, telling the pilot how far he is from his destination. These markers are small radio transmitters which send signals upward, in a generally vertical direction. When an aircraft flies over the location marker, the pilot hears a significant combination of dots and dashes in his headphones and simultaneously sees a light flash on his instrument panel.

Fan and Z Marker transmission are on 75 mc. The Z Marker, installed at LF/MF four-course radio range sites, provides a continuous cockpit light and continuous tone as a pilot flies over the range itself. This gives the pilot definite information concerning his location over the station. Fan Markers are installed along the airways at strategic points, and most of them are higher powered than the Z Markers. Fan Markers send out coded signals to help identify the range "leg" on which the marker is located. A variation of the normal Fan Marker is the low-powered Fan Marker which sends out a bone-shaped vertical signal that is relatively narrow and gives the pilot a more accurate position fix.

At the moment his aircraft is directly over a Fan Marker, the pilot knows exactly where he is along the airway. But the rest of the time he can merely estimate his position—a serious drawback to accurate navigation and to efficient traffic control. Since Fan Markers may be 100 or more miles apart, position estimates by the pilots are sometimes rather vague.

A pilot with a VOR Receiver is not wholly dependent upon an occasional Fan Marker to determine his position. He knows the bearing of the VOR on which he is flying by looking at the Omni-Bearing Selector indication. If he can receive a second VOR to the right or left of his course, he can obtain another bearing. The two bearing lines, plotted on a chart, will intersect. The point of intersection is the location of the aircraft. This procedure is a little cumbersome in a cockpit but, with practice, a fix can be obtained this way within a minute or two.

Some larger aircraft are equipped with dual VOR Receivers. This facilitates taking cross bearings as described above. The second receiver can be set in advance for a bearing which will be intersected at any selected point along the airway. The pilot flies with the first VOR Receiver in the usual way, and when he comes to the preselected point along the airway, the verticle needle on the second Deviation Indicator will move to center position. A pilot may also fix his position, with somewhat less accuracy, by flying a heading which is perpendicular to his VOR bearing and noting the rate of change of bearing. If he knows the ground speed of his aircraft, the pilot can calculate his distance from the VOR station.

Radio Homing and Direction Finding

A standard item in many aircraft equipped for instrument flight is a radio direction finder. This device tells the pilot the relative bearing of a radio station to which he is tuned.

Nearly everyone is familiar with the fact that by rotating a portable radio receiver, the volume can be varied. If the receiver is rotated through a full circle, there will be two volume peaks and two distinct low spots or nulls. The peaks occur when the loop antenna inside the receiver is pointed directly toward the radio transmitter. Nulls occur when the loop antenna points at right angles to the transmitter.

This principle is used in radio direction finding. A loop antenna is mounted on the aircraft and connected to a receiver. In its simplest form, the loop is fixed in position, and the aircraft is turned to locate the nulls, which are sharper than the peaks and therefore provide more effective direction finding. The bearing of the radio station can be determined by reading the aircraft compass at the moment of a null. Bearings obtained in this way are always ambiguous—that is, there are two directions, 180° apart, at which the transmitting station may be located. With this type of direction finder, which is largely obsolete today, the pilot must fly a special pattern to determine which of the opposite bearings is correct.

A second type of equipment has a loop which can be rotated manually, so the null can be found without altering the course of the aircraft. The bearing of the nulls is indicated by a pointer on an azimuth dial.

The most efficient type is the Automatic Direction Finder or ADF. This employs a loop which is automatically rotated and maintained in the null position by an electronically controlled motor. In this equipment, the 180° ambiguity found in other types is eliminated. The ADF, with its single-ended pointer, gives the pilot continuous information of the bearing of the radio station in relation to the aircraft heading. The pointer automatically rotates from forward to rear position as the aircraft passes over the radio transmitter to which the ADF is tuned.

In addition to direction finding, this type of equipment can be used for homing on a particular radio station. Radio beacons for homing purposes are operated in the same band as LF/MF four-course radio ranges—between 200 and 400 kc. Most direction-finding equipment also can be used in conjunction with commercial broadcasting stations operating on frequencies between 550 and 1600 kc.

Large transport-type aircraft usually carry two ADF's so that simultaneous bearings can be taken on different radio stations. The bearing indicators are mounted as a twin unit, and the installation commonly is called dual ADF.

Homing on a radio transmitter with a radio direction finder would seem, at first thought, to be like flying on a radio range. However, flying on a radio range results in a straight course to or from the range, regardless of crosswinds. With radio homing, crosswinds normally result in a spiral-like course to the transmitter. By careful navigation procedures with an ADF and gyro compass, this spiral can be largely avoided. However, homing navigation is at best less efficient than flying a radio range.

No one has yet developed a practical very high frequency direction finder which can be carried aboard an aircraft. As noted earlier, airborne direction finders operate in the static-ridden lower frequencies. Like LF/MF four-course radio ranges, direction finders are apt to be partially or wholly useless during thunderstorms and at other times when they are most needed.

Next month: A continuation of Part II: Elements of the Common System (Transition Period). This will include details of DME, Course Line Computers, Pictorial Displays, Airborne Radar, Ground Radar, etc. This material is reprinted with permission of Radio Technical Commission for Aeronautics. Skyways presents the Air Traffic Story as a service to its readers.

Skyways Round Table

(Continued from page 23)

Fred M. Glass: *"Non-passenger carrier?"*

Carl Agar: "Not in the strict sense. In the Kamano operation over the past two months, we have moved in and around the mountains some 400,000 pounds of freight and 900 passengers. I use the word, 'passengers,' in the sense that they were men employed by the company, and we delivered them to various sites of operation. When 'passengers', as such, are to be carried the twin-engine is a necessity."

Fred M. Glass: *"Do you operate entirely on day-contact, or do you operate at night, too?"*

Carl Agar: "No, all our operations are day. Night operation is out in that region."

Harvey Gaylord *(Vice Pres. & Gen'l Mgr., Helicopter Div., Bell Aircraft):* "Mr. Barnes, do I understand from what you said earlier that you envision a traffic density in intercity operations that would support a 40-passenger multi-engine helicopter transport?"

Leslie O. Barnes: "I'll give you two answers to that. Yes, we do have traffic today that, if we were providing the most complete kind of reliability and convenience to passengers in terms of time, would support a 40-passenger type of aircraft.

"Secondly, I believe that a study of the various types of vehicles in the past indicates that for a short-haul operation, 40-passenger vehicles have been accepted as optimum."

Availability of Helicopters

Fred M. Glass: *"Now that we've heard the requirements of the operators, let's hear from the manufacturers as to when, in their opinion, helicopters will be available to meet those requirements.*

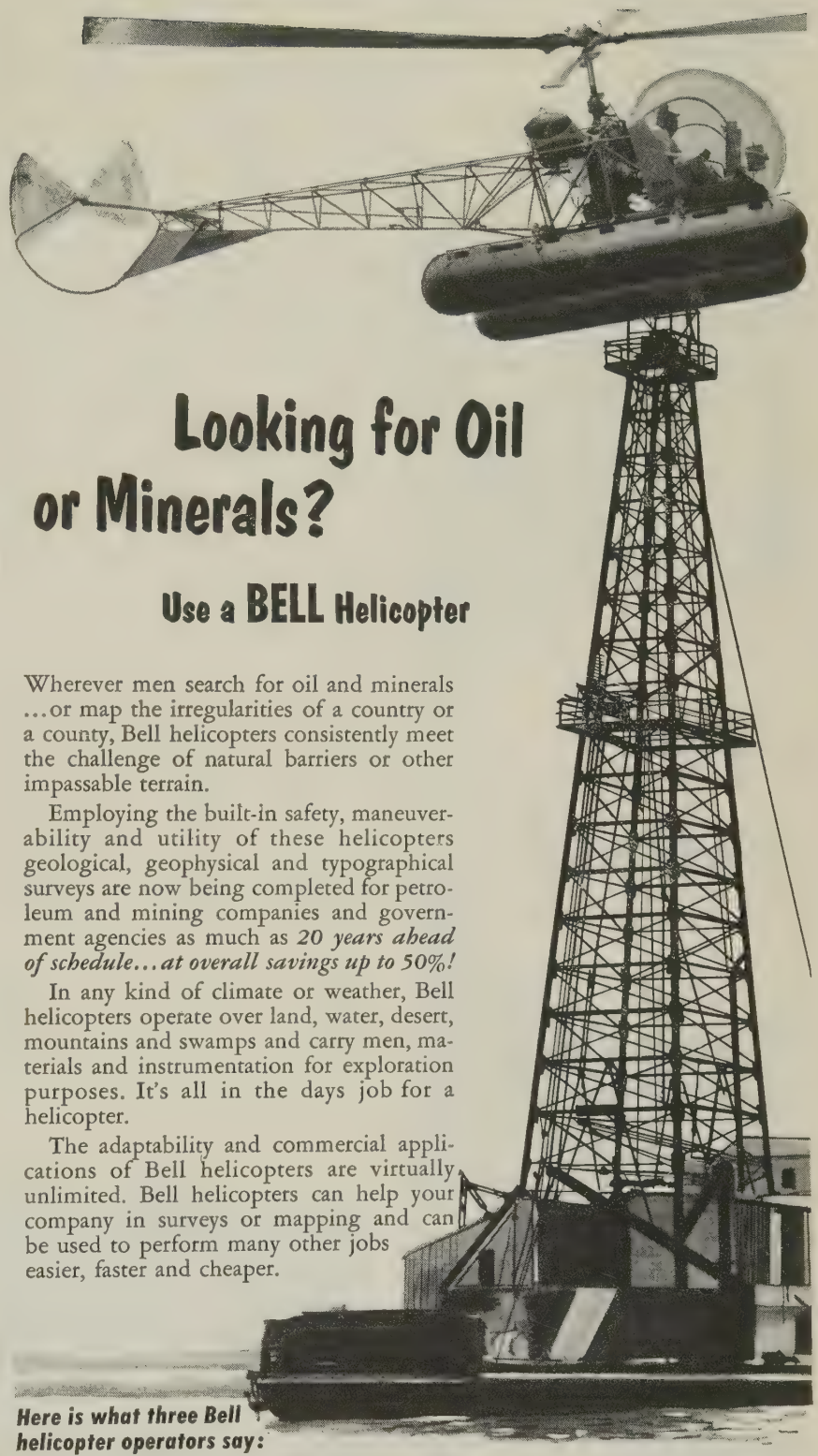
"Mr. Gaylord, would you express yourself on this at this time?"

Harvey Gaylord: "Your question probably could be better answered by someone who is actively developing a ship of that size. Depending upon military requirements, etc., Bell will have an 18- or 20-place commercial helicopter which may be available by 1956. I would guess that the time element for a multi-engine 40-place ship would be considerably greater than that."

R. A. Aspinwall *(Ass't Gen. Mgr., Sikorsky Aircraft):* "At the moment, Sikorsky customers are operating with the S-55. We have under development several classified military projects, one of which probably would be suitable for an operation that's something between Mr. Barnes' 40-passenger deal and Mr. Eastburn's somewhat smaller requirement. By the time we're in a position to deliver such an aircraft, I believe we will have developed enough figures to give Mr. Eastburn and Mr. Barnes something to work with.

"One of the big problems to a commercial operator is going to be his depreciation cost.

(Continued on page 52)



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"After more than four years' experience, we find the Bell helicopter the most satisfactory from the standpoint of cost maintenance and availability."—ROBERT L. SUGGS, President, Petroleum-Bell Helicopters, Inc., Lafayette, La.

"The survey accomplished by Bell helicopters in one summer would take 20 years by any other method."—JAMES S. RICKLEFS, Rick Helicopters, Inc., Los Angeles, California.

"Allied's Bell helicopters have done mapping and survey work intheRockies and Alaska at savings of 50% and more over other methods."—ROY B. DAVID, Allied Helicopter Service, Tulsa, Oklahoma.

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Skyways Round Table

(Continued from page 51)

That's been a problem in all airline operations, and it isn't going to be any different in a rotary-wing operation.

"With an aircraft the size they're talking about, it is only through military programs that we can get an aircraft that is going to be suitable.

"As far as time predictions are concerned, I'll go along with Bell on that and say that it probably will be 1956 or possibly later."

Fred M. Glass: *"Could you estimate the general range of cost of that machine?"*

R. A. Aspinwall: "I don't think we've developed enough information on that as yet. However, we feel that by the time we get through the military project and into the commercial operation, the high-cost portion of development will be behind us and we'll be able to make a price for the commercial version."

Fred M. Glass: *"Frank Piasecki, would you give us your slant on the various points that have been raised?"*

Frank N. Piasecki: "We've built two machines that I feel would be of interest to this group. The first is the H-21, a 20-passenger helicopter powered by an R-1820 engine of 1,425 hp for take-off. It is now under military procurement in a fairly large volume and has been flying for more than a year. This helicopter offers the range that Carl Agar talked about and also meets the requirements, from the metropolitan standpoint, of the smaller capacity market.

"The larger machine that we're building is the H-16. This has two engines. One version is piston-powered and the second version is a turbine-powered aircraft. Not much can be said about this helicopter because it's of a more restricted nature. However, it will have a capacity of well over 40 passengers and will have single-engine flight reliability as well as areas for ramps, steps and doors that are considered necessary for both freight and passengers. Its design permits attachment of a pod to the bottom of the fuselage, thus providing increased volumetric capacity for high-density areas where freight or passenger lines require additional service.

"I was particularly interested in Mr. Aspinwall's remark about the importance of first cost of the helicopter in relation to the cost to the operator. In some of our calculations as to the total cost of the helicopter and its cost per ton mile, we come up with a fleet depreciation in the vicinity of 10%. That's 10% of over-all cost—direct and indirect."

Fred M. Glass: *What do you consider indirect to be in relation to direct?"*

Frank N. Piasecki: "About 40 indirect to 60 direct."

Helicopter Powerplants

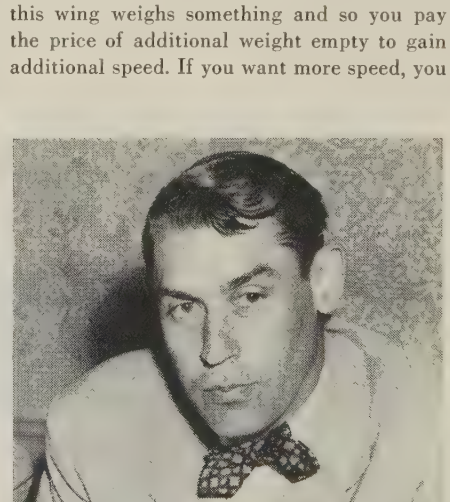
Fred M. Glass: *"In this matter of powerplants, Frank, do you think the availability of engines, turbine and/or reciprocal specifically designed for helicopters as distinguished from those basically designed for fixed-wing aircraft and later adapted to helicopters, is going to make a substantial difference in the efficiency and performance of helicopters?"*

Frank N. Piasecki: "I'd say it depends on the range over which you operate the helicopter. The turbine-powered 'copter supplies greater payload over short ranges up to 200 miles. If the operator, however, is going to try to conduct a long-range inter-city operation, perhaps the piston engine would be the choice, depending on which model helicopter you are speaking of, and which piston engine you are comparing with which turbine.

"As a generality, the turbine definitely offers a superior payload performance in the short-range operation."

Fred M. Glass: *"Do you think there is any ceiling to speed in the larger type helicopters? In other words, is there a relative range beyond which the cost of speed is too great in relation to performance achieved?"*

Frank N. Piasecki: "The speed of the helicopter as we know it today has an upper limit of about 170 mph . . . it may be 165 or even 185. The actual speed reached today by the helicopter has been 150 mph—V-max, although that is not the upper limit. When you want to go beyond those speeds, you have to do something to eliminate or at least delay blade-tip stall, and that means you have to unload the rotor or possibly add devices to the machine. The wings that you add to a helicopter could unload the rotor and thereby decrease the tip coefficient of the blade and delay the stall. That seems simple enough, except that there hasn't been a large amount of experience in that field. The old autogiro followed that line and a recent one is a development of SNCASO in France. However, this wing weighs something and so you pay the price of additional weight empty to gain additional speed. If you want more speed, you have to increase your weight empty and consequently you decrease the efficiency of the machine in regard to payload."



"TURBINE *installation in our helicopter has given us few problems," said Mr. Kaman*

helicopters, what does your experience indicate with regard to stability and the consequent ability to use the auomatic pilot or to make precision instrument approaches or to have night operations?"

Frank N. Piasecki: "It has been possible to design helicopters to be stable in forward flight, and some of the manufacturers represented here at this Round Table have designed machines that are fairly stable in near hovering flight. However, no one as yet has designed a fully stable machine in hovering condition. Providing these performance characteristics is very difficult because there is no point of reference except gravity. The automatic pilot has been used as a means of providing ésthetic stability in the machine by taking this reference force, amplifying it and putting it into the control system. Automatic pilots have been installed successfully and they do give an automatic hovering stability to the 'copter as well as stability in forward flight as they do in an airplane. In addition, the automatic pilot makes it possible to use all the modern developments of automatic flight, such as Zero Reader or radio course system, in which the information is picked up by the autopilot and actually flies the machine on a pre-determined course."

Richard K. Waldo *(Chief Economist, Planning Staff, CAA):* "I wonder if we could back up for a moment. Frank Piasecki mentioned the attractiveness of the turbine engine for the helicopter and he reported that the H-16 would have turbines. I believe Bell is also developing a turbine-powered helicopter. Recently, at the IATA technical conference in San Juan, I got the impression that there might be some difficulties in connection with twin-turbine aircraft and helicopters, because of the high percentage of available power at which you would normally be cruising and accordingly the narrow power margin you would have in the event of failure of one engine. It was suggested that it might be necessary to go to three or four engines. I'd be very interested in getting some reaction to that, particularly from Charles Kaman."

Charles H. Kaman *(President, Kaman Aircraft):* "We have successfully flown a gas-turbine installation (split-wheel type) in the helicopter and have been amazed at the minimum of development problems. There is speed control with altitude, but the droop characteristics of the turbine governor have to be developed further. All in all, however, the problems did not develop as we had expected they would. Other problems took the forefront.

"One of those was the dissemination of the turbine gases. We found a tremendous amount of feed-back of exhaust through the system which rapidly deteriorated the efficiency of the turbine. We have since found ways of overcoming this.

"We also found that we would have to develop an auxiliary speed control since there is virtually a complete separation between the engine and the rotor system with a split-

eel turbine as compared to the reciprocat-
g drive which is continuous.

"Speaking of the split-wheel type of tur-
he, over and above these problems we do
t see any limitation as to numbers of tur-
hes—two, three or four. At this time, the
timum appears to be a twin turbine for a
mber of reasons. First, the obvious require-
nt for a turbine-powered helicopter is ef-
iency in fuel consumption. If the helicop-
r is designed so that it can maintain a satis-
tory cruising speed with one turbine op-
ating at full power, it becomes a fairly ef-
ient system. Then the remaining turbine
a reserve and, with adequate starting
eans, it can be brought into play quickly
the event of an emergency. Fuel consump-
on is, therefore, the reigning factor.

"We have found that the turbine is very
efficient the minute you start operating at
ything approaching 50% or 60% throttle.
the idling condition the fuel consumption
30% that of full power. Therefore, I think
e multi-turbine installation in helicopters
sts with the practicality of fuel consump-
on, and so of necessity the design will have
incorporate a minimum of powerplants but,
suming two, of such proportions that the
achine can operate efficiently on single en-
ne and maintain the other turbine for re-
rve power.

"While I have the floor, there are a couple
other points that I'd like to bring up. One
the paramount advantages of the turbine
stallation is that it is very quiet. The decibel
el is a very small fraction of that of the
nventional reciprocating engine. In fact, the
tor noise becomes predominant. In consid-
ation of the helicopter for metropolitan use,
think the noise advantage is important."

ank N. Piasecki: "Isn't that somewhat modi-
d by the fact that the turbine you were
sing had fairly low tip speed, and as you
t into higher compression turbines there is
oing to be a whine produced by the high
p speed?"

harles H. Kaman: "That's true, but we also
ad a whine. There is this basic factor as-
ociated with it insofar as we've been able
o determine: turbine characteristics are at
ne high end of the audio range of human
eception, and to get more power and to
urther amplify the turbine characteristics,
ou run further out of the audio range with
nost of the harmonics of noise level within
ne turbine. It makes a fantastic amount of
oise, but we can't hear it.

"Another point I'd like to make is that we
ave found that, when the turbine is de-
eloped a little further structurally, mainte-
ance is going to be an exceedingly attrac-
ive feature of the turbine installation in that
t has basically fewer components.

"For this last point that I want to make,
e'll have to come back to the operating
eople. I've heard a lot of discussion, not only
ere but in the past, of the size of the multi-
assenger machines. We all certainly recog-
ize the necessity of scheduled operation and
egularity in order to realize economic justi-
ication. However, in exchange for that regu-
arity of load and that regularity of day-to-day economic operation, the operator must carry the burden of higher initial cost and higher amortization of overhead. Everyone probably realizes that even with the military support the price of multi-engine large-size helicopters is going to be high. And this brings up an area of speculation that is of interest to our company because of our participation in the relatively smaller size helicopter field. We have a helicopter presently under development for the military which, in a few years, will come forth possessing the characteristics you operators have named as desirable. It will be capable of flying in all kinds of weather; it will have stability, reserve power, etc. However, it is a small helicopter and not in the large multi-engine category. Now, recognizing its limitations from the large size point of view, if it can carry with regularity and reliability a smaller load, what is the sphere of application of this helicopter to your particular operations?"

Fred M. Glass: *"How much smaller is it?"*

Charles H. Kaman: "It will have a payload, ignoring gas and pilot, on the order of 1500 pounds. As a passenger vehicle, it is a four-placer at the present time, but it will have provisions for external load carrying and it will internally have the cubical content for bulk freight. Also, it will handle this 1500 pounds with such performance as to be able to hover out of ground effect at substantial altitudes, etc. I wish I could divulge more of it, but right now it's a classified project."

Carl Agar: "When we're given a payload figure, Charlie, we want to move that payload with full tanks of gas. I think it's pretty generally known that when your payload is the maximum quoted, it means you're having to operate with the gas tanks half full. We operators get into a very embarrassing position with our clients. They hear us talking about certain payloads, but then we can't take them too far. We'd like to be able to take our payload some 100 or 150 miles distance and then return and have plenty of reserve. What you are talking about sounds very interesting if you mean 1200 or 1500 pounds with full tanks of gas. That's important to us."

Charles H. Kaman: "Without being specific about our particular type of aircraft, might I interpret your comments to mean that if we had an aircraft that had three or four hours at a cruising of 80 to 100 mph and, without compromising that capability, could handle a load of 1500 pounds in the bush country at altitudes up to between 5,000 and 10,000 feet, you feel that it would have large commercial applications?"

Carl Agar: "Yes, it would fit a phase of operations that may be with us for five, six, seven or maybe 10 years. There is no question, however, but that we're going to eventually move into the bigger helicopters, but we're going to first have to go through a phase with the medium-sized ship which is going to be of great value to industry in opening up Canada . . . and we've got a lot of country to open up! Until better helicopters are available, the two types we are using today are giving us excellent service."

(Continued on page 54)

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Skyways Round Table

(Continued from page 53)

Glidden S. Doman *(President, Doman Helicopters):* "I'd like to echo Charlie Kaman's sentiments regarding the twin turbine. We've been making similar studies in our organization and agree with everything he says. Further, because of operating economy and not because of any safety angle, three turbine units may be what you want.

"If I may, I'd like to outline our present position. We have nothing that is restricted; we are a privately financed organization and we've been forced by circumstances to try to think in terms of what is going to be a suitable product for the commercial operator. I've spent a great deal of time studying operations on the order of Mr. Eastburn's and Mr. Agar's, and I've also talked with representatives of some of the major airlines who have begun extensive investigations of helicopter operations. I found the 40-passenger minimum concept to be very common in those circles. Frankly, I sympathize with those who are waiting for that machine, but I'm going to bet on Mr. Agar and Mr. Eastburn as far as the immediate future of the helicopter commercial manufacturing business is concerned."

Fred M. Glass: "*Could we summarize or generalize on what seems to be the consensus of expressed desires on the part of the airlines as to a helicopter?*"

Glidden S. Doman: "These fixed-wing people tell me they must operate rotary-wing aircraft on a 200 or 250-mile range without refueling —a lot of stops but no refueling because they can't afford to have refueling equipment at every station. When we are going to give them that, I don't know. But I don't think New York Airways needs that. One thing we do believe is that there is definite utility in the turbine ship. As a matter of fact, we have every expectation of recertificating our present 'copter for use with a pair of turbines and putting the operator in a position to convert existing ships to and from turbines. This is the ship which will be certificated in a few months for the mechanical setup. It is quite close to what Charlie was describing: it has a useful load of about 2,150 pounds with reciprocating engine. What it's going to be with its fuel tanks filled, I don't know, but I'd guess it would run close to 1500 pounds.

"One of the most interesting things that I've been told by the major airlines is that they believe the depreciation of the ship to be an important factor. Charlie Froesch of Eastern mentioned that, and when I asked him if he meant wear and tear of the ship on itself, he said he'd heard a lot about that but what he was talking about specifically was the wear and tear of the designers on the ships. He said that the ships would be obsoleted by new designs so fast that they'd have to count on self-cancellation in five years."

Develop Helicopter Utility

E. Tug Gustafson *(Ass't to the Sales Mgr., Sikorsky Aircraft):* "I more or less agree with Mr. Doman's contention that the problem is for the manufacturer today to sell what he's got. To answer the question of who's going to buy, we'll have to back up a bit and figure out how the helicopter that we have today came to be. You'll remember that in 1946 when the first helicopters were being made available, all we had to sell were two-place and four-place helicopters with 300- to 800-pound payloads respectively. So we went around to various industries to see where that kind of payload and performance could best fit into an operation. This same problem exists today, whether you're talking air transportation in high-density areas or in the oil or mining industry. Part of our business as a manufacturer is to analyze the situation to find out where we can sell what we have today. It's only recently that the airlines and others have begun to talk about 40- or 50-passenger helicopters to get into this short-haul transportation market, and I believe the reason for that is that only recently has the industry let it be known that helicopters of that size are going to be available.

"Actually, our job is to go out and develop its utility. For example, we know that a great market is going to exist in the inter-city and high-density metropolitan areas. It is also believed that same type helicopter will find its way into airline operations in such areas as the Gulf of Mexico, the Lake Maracaibo region of Venezuela and possibly the Persian Gulf where the oil industry must daily deliver many men to operations 50, 60, and even 100 miles off shore, land them on small oil-drilling platforms, and then each night return them to the mainland. We have gone to these oil-drilling companies and stated that we have helicopters today, small ones and large ones, that could serve their particular transportation needs. We definitely believe that the small helicopters, the medium-sized ones, and some day the 30 and 40-passenger models, will go into that type of operation.

"Also, in Canada, the area Carl Agar talks about, there lies a great future for a helicopter of the type Mr. Kaman referred to.

"What the industry really has to do is to go out into the various industries and explain to them what we have and how it meets their existing needs."

Daffy-nitions

Flight Engineer: A fellow who, when not protecting the pilots from the stewardesses, keeps the books. And when not otherwise busy, his duty is to sneer at piloting technique.

Mechanic: A lad who knows what is the matter but asks the crew chief for the fun of it.

Hy Sheridan

R. A. Aspinwall: "While it is always very interesting to look ahead to 40-passenger helicopters, we have to consider what we have to sell today. We may progress faster than the conventional aircraft industry did—and we hope that economical factors will be different, but there's going to be this area between today's 5-passenger or 10-passenger 'copters and the future's 40-passenger model."

Fred M. Glass: "*As I understand it, the operator's problem is the result of the competition of surface transportation and also fixed-wing transportation where passenger/mile rates are down to the 5½ and 6 cent level first-class, and 4½ and 5 cents tourist-class. The operators feel that they aren't going to be able to sell 125- to 150-mph air transportation until they can sell it at about those competitive prices. Therefore, the problem that you manufacturers face, as I understand it, is that you've got to produce a helicopter, whether it's 8-passenger, 15 or 25, that will operate cost-wise somewhere in the competitive range.*"

Frank N. Piasecki: "I agree with you 100%. There is no question but that there is a large market for the machine that has been discussed here, namely, one with a 1500-pound payload. The thing to remember, however, is that operators, especially the airlines, will not put a machine into service that is not economically justifiable. We can't force operators to take something they don't want. On the other hand, there are plenty of markets for these other types, so I don't see that there's any argument here at all."

R. A. Aspinwall: "My point is this: usually conversations such as these are slanted entirely toward airline operation. In this Round Table discussion, however, with Carl Agar representing a non-scheduled operation, we at last have a chance to develop something in that area that exists between what we have today and the 40-passenger helicopter.

"After hearing Mr. Barnes' comments and also Mr. Eastburn's, I feel there remains some question as to size of helicopter. Mr. Barnes talked about a 40-passenger, and Mr. Eastburn something less than that. Perhaps the final answer has to do with frequency of operation."

Glen B. Eastburn: "As far as the experience of N. Y. Airways is concerned, we are finding frequency of vital importance in customer service, and perhaps it's fortunate that in our development of new patterns of transportation, new patterns of merchandising and market service we're starting out with small machines. Our rates can be higher than those outlined by Mr. Barnes because we are serving a premium traffic. Of course, if the cost could be lowered to a point that would compete favorably with surface transportation that would be fine, but we're serving a premium traffic all the way around, and we don't believe we've scratched the surface of the potential, even on the present equipment.

"New and more efficient equipment would open up additional markets, but we feel there is a real demand for the transportation we are offering as we develop it. In fact we've been extremely cautious in the develop-

nent of our freight haulage. While we've ublished a freight tariff and are now ac-epting freight, we've been fearful of push-ng it too hard because of our limited ability o handle it.

"The acceptability of the helicopter in eighborhood areas or population centers is ery important, and I've been very interested n the discussion we've had here on the possi-ility of quieter power. Also, increased lift would enable us to serve our customers better. Definitely, the medium-sized ship with sched-le frequency seems to meet our needs."

Business Use of Helicopters

red M. Glass: "*There's one phase of this heli-opter situation that we haven't touched on et and I think it would tie in right here. ean DuBuque, would you give us your com-nents regarding the place of the helicopter n the business-flying field?*"

ean H. DuBuque *(Exec. Director, National Business Aircraft Assn., formerly known as Corporation Aircraft Owners Assn.):* "While nost of this discussion has concerned the daptability of helicopters for airline use, nuch can be said of the helicopter's potential se in business flying. I feel that there is an ntapped market in the corporate field. At the present time, there are over 5,000 organiza-ions in the U. S. utilizing approximately 0,000 fixed-wing aircraft in connection with heir business activities. I'm certain you'll nd that hundreds of these organizations have ubsidiary plants lying within a 200-mile adius of their home plants. These organiza-ions could very effectively use rotary-wing ircraft in connection with their operations.

"The Rockwell Corporation in Pittsburgh, or example, uses an S-55 in contacting their lants in Pennsylvania and Ohio. Certainly, here is a definite advantage in being able to ake off from a parking lot adjacent to the ome office and fly to other plants in the 100 r 200-mile neighboring area.

"In order to interest business organizations n the purchase of helicopters, these ma-hines will have to meet the basic aviation olicy which most companies operating fixed-ing aircraft follow, namely, safety, service, nd economy.

"Safety, of course, is of utmost importance. When the helicopter has demonstrated its bility to fly under all weather conditions and when the necessary automatic aids to air navigation are available so that the top execu-ives of these companies can be flown to the outlying areas in complete safety, then I be-ieve companies would be interested in the possibility of supplementing their fixed-wing ircraft with rotary-wing aircraft.

"Service is next in importance. The heli-opter has to be available on an hour's notice o go to the different places designated by company officials.

"In the matter of economy, unless you can ave an economy of helicopter operation omparable with that of present fixed-wing ircraft, the potential business market would e rather limited.

"A helicopter having a speed of 150 mph

(Continued on page 56)

Welcome to America's Premier Aircraft Show—the first truly national and completely integrated exposition of American Aviation.

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Here, as at no other time or place, industry in cooperation with the U. S. government will show the scope and complexity of air power in every aspect.

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Skyways Round Table

(Continued from page 55)

or more should definitely prove of advantage to many companies using fixed-wing aircraft. At the present time, in order to use their fixed-wing aircraft, executives must travel from the home office to the local airport and then when they have been delivered to their destination airport, they must travel from that airport to the plant they are visiting or other official contact. With a helicopter, the executives can travel in a direct line from the home plant to whatever point they desire, resulting in a great saving in time. But, until the safety, the service and the economy of the rotary-wing aircraft have been proved, the market in the business field will be somewhat restricted."

Fred M. Glass: "*What size machine would most business-aircraft owners want?*"

Jean H. DuBuque: "In discussing that point with some of our members, I found two types indicated—one a four-passenger, and another a five-to-eight passenger. The preference is for the second type to be twin-engine, especially from a safety point of view."

Development Subsidy

Leslie O. Barnes: "I'd like to get back to this matter of frequency again. I think that sustainable frequency that is supported by demand is the direct product of distance. In other words, there'd be more trips in a metropolitan inter-airport operation than there would be inter-city. We'll probably also find that the longer the distance and the more infrequent the number of operations you have, the larger the vehicle must be.

"A question was asked during intermission that I'd like to repeat and put on the record here. Must there be a steady progression in the development of the helicopter from four to 10 to 20 to 30 and then to 40 passengers, or could we logically go from a 10-passenger 'copter to a 40-passenger one? There is no replacement available today for the DC-3 type airplane, and we may well see the passage of the twin-engine type fixed-wing aircraft within the next decade. That being the case, I should think there'd be a big market for a 40-passenger or 30-passenger interim ship."

Glidden S. Doman: "To me, the problem in getting from a 10-passenger to a 40-passenger rotary-wing aircraft is one of incentive. Perhaps the airlines, collectively or otherwise, should finance the development of such a ship. My suggestion is that the airlines that are interested in a helicopter of such-and-such a size make that fact known to the airlines' steering committee under ATA. They should announce their intention of holding a design competition and letting a development contract to somebody in the industry for the ship they need. As far as the question of whether or not the airlines would be able or willing to finance it, I doubt that they'd have to. I think the military would be interested in it and I think other agencies of the government would be interested in it, but I think that it should originate with the airlines. The specifications this committee draws up should be used as a sort of a threat of an independent, economically prompted development and the committee should start off thinking in terms of making a product that will earn money."

Fred M. Glass: "*The committee that Mr. Doman has referred to is represented here by its secretary, Mr. Don Talmage, of the ATA.*"

Donald B. Talmage *(Asst. Dir., Engineering, ATA):* "As far as this recommendation that we let a development contract is concerned, let me remind you that the airlines also are in business to make money. An airline institutes a service over a given route, and it may not make money over that route, just the way a manufacturer may not make money with his different products. It is the old story of free enterprise—we both gamble on the potentialities of the helicopter. We can tell you that we think there is a considerable market for the 30-to-50 place multi-engine helicopter and we can give you other details which we feel should be incorporated in the design, but I don't think we can go so far as to underwrite the development costs."

Helicopter Facts

The rapid advancement of the helicopter is reflected by the fact that the estimated 2800 helicopters thus far produced in the U. S. have flown some 1,200,000 hours . . . that's equal to 137 years of flying. Helicopter manufacturers now have 13 models in active production.

Harvey Gaylord: "If we're going to get a 40-passenger helicopter within a reasonable period of time, it's undoubtedly going to be developed for the military, and the requirements that the military have are going to govern the design of the ship. All we can do is hope that those requirements will be close enough to commercial-transport requirements to permit modification to suit the commercial need without undue difficulty."

Glidden S. Doman: "That's just the point I disagree with. I say, let's not hope that the military specs bring the operator what he wants. Let's have the operator write his own specs and then let's see if we can't get the military interested in it."

Harvey Gaylord: "That's like the Ethiopian girls; they may not be attractive to everybody but they're here. The fact is the military is already sponsoring large helicopters and, from a practical standpoint, these will be the only ones available for commercial work in the foreseeable future. I know of no company that has the resources to develop equipment of such size entirely on its own."

Frank N. Piasecki: "We have been building the XH-16 to military specifications since 1945. It just so happens that British European Airways' commercial specs read directly on the military specifications of the XH-16. By directly, I mean within certain tolerances. Therefore, I don't think it's necessary to assume that military specifications will not produce a desirable commercial plane.

"On the other question that is on the floor—can you go from a 10-passenger machine to a 40-passenger, I might add that we've had no difficulty in going from a 10-passenger to a 20, so I don't see where there'd be any major difficulty in going from 20 to a 40."

Frank N. Piasecki: "All products, regardless of whether they're 5-passenger or 40-passenger must go through certain tests and serviceability determinations. It doesn't make any difference whether you have a 5 or 40, the intensity of your tests and your reliability determination are the same. Consequently, from the standpoint of reliability, the machines should be equal. From the standpoint of applying the machine in your service, most airlines have no helicopter experience anyway, and so to them it won't matter if they go directly into larger machines. It certainly would be nice, however, if they prepared themselves with smaller machines for training purposes."

Donald B. Talmage: "The ATA committee has been working on some rotary-wing aircraft specifications and we plan to continue and eventually draft a fairly detailed spec which, of course, will be made available to everybody. Now, the relationship between the specification which we draft and the military specification is, in our estimation up to the manufacturers. It's up to the manufacturers' ingenuity to merge the two so that you come up with a helicopter acceptable to both."

R. A. Aspinwall: "The helicopter industry is in an advantageous position when compared with the conventional airframe industry manufacturing fighters and bombers which cannot normally be modified for commercial use. In many instances, the military mission of the helicopter is similar to the mission of the airline operator. Our gain in that respect, where we do get military sponsorship, is that we are closer to commercial version than the average airframe manufacturer."

Charles M. Kaman: "I rather disagree with Mr. Doman on his comment regarding the creation of a threat to the military. In needing an incentive, I'd say national defense is pretty compelling and it isn't entirely divorced from economics but is predicated on the necessity of technical achievement. On the other hand, we have the sphere of commercial operations where it is a dollar and cents proposition on operation as divorced from the stages it takes to get to that point. I heartily concur that it would not be consistent with the democratic system of development if the commercial people were to single out and develop any one particular type.

"I also share Mr. Piasecki's, Mr. Aspinwall's and Mr. Gaylord's point of view as to the resemblance between military application of the helicopter and the commercial.

"The helicopter industry, as compared to other well-known industries, has enjoyed a

henomenal rate of growth and accomplishment of a technical nature. It certainly justifies confidence in our being able to achieve the remaining steps in reasonable development phases. The application of a military machine to commercial use involves adaptations within the design structure which are of a minor category compared to the basic design elements of the rotor system, power transmission, etc., that go into basically making the aircraft fly. This area of technical development naturally involves a considerable degree of research and development, as has been our history, and I think we've earned the right to stand on our own feet under the incentive of national defense to carry forward.

"Lastly, I feel that the more cooperation we can inspire between our commercial people and our military people, the more constructive is going to be the final result."

Leslie O. Barnes: "Mr. Kaman, I think that's an especially important point, because the whole concept of air-transportation development today is a reserve for the military in the event of a national emergency. Certainly, helicopters of the type we're talking about will play a major part in such a reserve."

Richard K. Waldo: "Getting down to brass tacks on the kind of helicopters that are going to be available between now and 1960, Frank Piasecki and Harvey Gaylord have said they are each going to have a 20-passenger ship; Sikorsky has suggested that they will have a 30-passenger, and Piasecki, a 40-plus passenger ship. Each of these is being developed under military auspices, so the first commercial ships, it appears to me, will be outgrowths and adaptations of these military helicopters. I'd like to suggest that there may be a few things we in the CAA could do to help in the transition from the military to the civil ship. First off, it would be a fine thing if our airworthiness requirements and those of the military were closer together. Second, I feel it would be a splendid idea if the manufacturers who have these large ships and intend to develop them further for commercial use were to get the CAA into the act as early as possible in order to minimize the delays and costs involved in the modification of these ships for civil type certification.

"A third suggestion—perhaps we have been long enough in the thinking, planning, writing and talking phases of this business in an attempt to get some of the answers to the questions facing us, and maybe now we should be getting to what you might call the experimental operational phase. There was some strong feeling at the recent IATA Helicopter Symposium that an accelerated service testing program of existing large military helicopters under simulated airline operating conditions could produce a great deal of benefit to everyone in this industry.

"I'd like to get this group's reaction to that idea, and to assure the group of the CAA's very keen interest in it."

Harry Pack *(Vice Pres., Piasecki Helicopter, speaking for Mr. Piasecki):* "We feel very strongly that such an idea has merit. There is only one way that reliability and good service

(Continued on page 58)

SKYWAYS

AIRPORT SERVICE GUIDE

An up-to-date, accurate, detailed listing of aircraft services and products available to single and multi-engine operators throughout the U.S.

DELAWARE

WILMINGTON—New Castle Airport. *ATLANTIC AVIATION:* Two concrete & steel, storage $1.50 to $7.50 nite; single-eng tie-dwn $1. *GULF* 80-91-100. Line svce 7 a.m.-11 p.m.; A&E, 50-man CAA shop; major single & multi-eng. Eng parts: P&W R-985, *CONTINENTAL* E-185, A & C series, *LYCOMING* O-290D. Major radio, install & svce all radio, full bench test; minor instru; major airframe to DC-3; wash, polish, paint. clean. Dealer: *CONTINENTAL* 90 & E-185, *LYCOMING, BENDIX, NARCO, ARC, LEAR* (inc L-2), *BEECHCRAFT* 35 & D-18S, *PIPER* 18 & 22, *GOODYEAR* (brakes, tires). Taxi, rental car. Food nearby 24 hrs; motels nearby; pilot lnge; chrt air svce. Airport: 5.8 mi SW; el 75; lat 39-40, long 75-36; no lndng fee; Wash cht; tower, CAA 120.9 mc & 230 kc; radio, two-way required, class MRLWZ, range, 24 hr oper. Paved runways: 4, longest 7000; 40:1 apprch; beacon. G. Edwin Petro, Mgr, Tel 2026. Airlines: AAA, AAL, EAL, TWA, SLI.

DISTRICT OF COLUMBIA

WASHINGTON—National Airport. *BUTLER AVIATION:* Fireproof hangar; *SHELL* 80-91-100-115-145; line svce 24 hrs; A&E 24 hrs; major single & multi-eng, radio, instru, airframe; eng chnge; wash, polish, paint, int clean; complete weather; taxi, bus, limousine, HERTZ, sta wagon; pilot lnge; food 24 hrs. lodging. Dealer: *P&W, CONTINENTAL, DOVE, LEAR, COLLINS,* misc tires, parts, access. Airport: Gov't; 5 mi S Wash; Wash. cht; lat 38-51, long 77-02; paved rnwys—NW 5110, NE 4760, N 6/40, E 3825; field marks, beacon, lights, cntrl twr, ILS, GCA. Cmrcl aircraft lndng fee based on wt; parking fee. B. H. Griffin, Dir. Airlines: AAA, AAL, CAI, CAP, EAL, NAL, NWA, Resort, TWA, UAL.

GEORGIA

ALBANY—Albany Municipal Airport. *ALBANY AIR SVCE:* Metal hangars; tie-dwn .75 nite; *STANDARD* 80-91; line svce (A&E), day; major, minor single-eng & airframe; misc single-eng parts; wash, polish, paint; *HERTZ,* taxi; weather, tel 836; food airport day; lodging 5 mi; pilot lnge. Airport: 5 mi SW; el 195, lat 31-35, long 84-10; no lndng fee; Albany radio; Mobile cht. Blacktop runways: 3, longest 4960. Beacon. Thomas C. Ferguson, Mgr, Tel 3164. Airlines: EAL, SOU.

AMERICUS—Southern Field—*AMERICUS FLYING SVCE:* 2 metal hangars, $1.50 day, $10 mo; *STANDARD* 80; line svce 8:30 a.m. to dark; A&E; major & minor single & multi-eng; radio svce in Americus; eng parts by order. Dealer: *CONTINENTAL, LYCOMING, PIPER, CESSNA.* Taxi. Food on field 7:15 a.m.—5 p.m.; lodging nearby. Airport: 4.5 mi NE; el 470; lat 32-07, long 84-11; no lndng fee; Birmingham sect cht. Unpaved runways: 2, longest 5000 (slippery when wet). Obstr: Power line NE rnwy. Ralph Kiker, Mgr, Tel 2813.

KANSAS

DODGE CITY—Dodge City Municipal Airport. *MAHON'S FLYING SVCE:* Brick hangar, fees $1.50 to $5. No lndng, tie-dwn fee. *PHILLIPS* 80-91-100. Line svce day hrs, on call nite; A&E 8 a.m.-6 p.m. Major airframe & single-eng, minor multi-eng & radio; parts *CONTINENTAL* to 240 h.p., *LYCOMING* to 135 h.p., *FRANKLIN* to 165 h.p., *JACOBS* 225 h.p.; Wash, polish, paint, int clean. Dealer: *CONTINENTAL, NARCO, ERCOUPE, BEECH, CESSNA, DELCO-REMEY, GOODYEAR, BENDIX, SCOTT, HICKOCK* (test equip.). Weather, taxi, food on airport 9 a.m.-8 p.m., lodging 1 mi; Pilot lnge. Airport: 3.5 mi E; el 2594; lat 37-46, long 99-58; no lndng fee; Unicom 22.8; CAA radio 24 hrs; Wichita cht. Rnwys: SE-NW & SW-NE 4650 paved, E-W 1650 grass. Bndry lits, beacon. T. B. Gebhart, Mgr. Tel 1405. Airline: CAL.

TOPEKA—Topeka Municipal Airport. *TOPEKA AIRCRAFT SVCE:* T hangars, $20 mo; storage $1.50 to $5 nite; no lndng fee; *SOCONY* 80-91-100; line svce 24 hrs, A&E day; major single & multi-eng, airframe; minor radio & instru; prop overhaul; *CONTINENTAL* E-185 parts; wash, polish, paint, int clean. Dealer: *CONTINENTAL, LEAR, NARCO, BEECH.* Taxi, *HERTZ;* weather; food on airport 7 a.m.-9 p.m.; Food to go: 3 hr notice required, delivered to aircraft. Lodging Topeka; pilot lnge. Airport: 3 mi NE; el 886; lat 39-04, long 95-37; Kansas City cht; hvy aircraft lndng fee; tower, beacon, lights, VOR, ILS, 24-hr oper. Paved runways: N-S & NW-SE 5100, NE-SW 4300. Field marks. Obstr: Bridge SE, lighted. Owen W. Griner, Mgr, Tel 2-0820. Airlines: BNF, CAL, OZA, TWA.

MONTANA

BELGRADE—Gallatin Field—*LYNCH FLYING SVCE:* Steel hangar, $1 to $3.50 nite, $15 to $100 mo; no tie-down fee; *CHEVRON* 80-87; line svce, major & minor single, multi-eng; major radio, airframe; eng parts. Dealer: *CONTINENTAL, JACOBS, NARCO, LEAR* (inc auto-pilot), *CESSNA.* Taxi, *HERTZ,* car rental. Weather, food on field 9 to 5; pilot lnge; no lodging. Airport: 9 mi NW Bozeman; el 4461; lat 45-46, long 111-09; radio (Insac); lights, beacon; Yellowstone Pk sect cht; Runways: 2 paved, 2 turf, longest 5200. J. A. Monger, Mgr, Tel Belgrade 73. Airline: NWA.

HELENA—Helena Municipal Airport—*MORRISON FLYING SVCE:* Alclad hangar, .50 per seat. No tie-dwn fee. Fuel 80-91-100. Line svce day, on call nite; A&E 8 to 5; major single & multi-eng, radio, airframe; wash, polish, paint, clean. Dealer: *CONTINENTAL, FRANKLIN, CESSNA, AERONCA. LEAR, NARCO* svce. *HERTZ,* taxi. Weather, tel 396. Food on field day; lodging nearby; pilot lnge; all major crdt crds. Airport: 1.5 mi NE; el 3893; lat 46-30, long 111-59; Butte sect cht; no lndng fee; radio, lights, beacon. Pved. rnwys: 3, longest 5200. H. R. Kelleher, Mgr, Tel 2014M. Airlines: NWA, WAL. (Over)

With this issue, SKYWAYS introduces a portion of a new-type directory which, for the first time, provides aircraft operators with detailed information concerning services they can expect at the nation's airports. The listings shown here will be supplemented each month in the pages of SKYWAYS.

AIRPORT SERVICE GUIDE

(Continued from previous page)

MONTANA

MISSOULA—Missoula County Airport—*MISSOULA AIR SVCE:* Hangars for lght & small 2-eng arcrft; no tie-dwn fee; *TEXACO* 80-91-100; line svce all hrs on rquest; A&E; major & minor single, multi-eng; minor radio, instru. Dealer: *CONTINENTAL, LEAR, PIPER.* Taxi, *HERTZ.* Food on field 9 to 7; lodging Missoula; pilot lnge. Airport: 4 mi NW; el 3200; lat 46-54, long 114-05; Spokane sect cht; paved runways: 4, longest 7000; beacon, bndry & rnwy lights, weather. Geo. Burkhart, Mgr., Tel 2471. Airline: NWA.

NEBRASKA

GRAND ISLAND—Grand Island Airport—*NEBRASKA FLYING SVCE:* Hangars 1 conc, 1 wd; rates $1.50 to $15. Tie-dwn. *PHILLIPS & TEXACO* 80-91-100. Line svce, A&E 24 hrs; major & minor single-eng, airframe, minor multi-eng; wash, polish, paint, clean. Dealer: *CONTINENTAL, LYCOMING, NARCO, LEAR, PIPER.* Taxi, *HERTZ.* Weather, food 7 to 7, lodging nearby; Food to go: 2 hr notice required, dlvy to aircraft; pilot lnge, Airport: 4 mi NE; el 1846; lat 40-58, long 98-18; lndng fee .02 per gal; radio, lights, beacon; Lincoln sect cht; Paved runways: 3, longest 7200. Chester Moore, Mgr., Tel 3671. Airline: UAL.

IMPERIAL—Imperial Municipal Airport—*IMPERIAL FLYING SVCE:* Hangars, metal, $1.50 per nite. No chrge tie-dwn. *MOBILGAS* 80. Line svce 24 hrs, A&E. Major light aircraft eng, minor radio & instru, new & used eng parts on short notice; wash, polish, paint. Dealer: *LYCOMING, CONTINENTAL, MOONEY, PIPER.* Weather svce; courtesy car & no chrge; food at airport 6 a.m.-11 p.m.; lodging Imperial; pilot lnge. Airport: 1 mi Imperial; el 3280, lat 40-31, long 101-37; no lndng fee; radio tower; VHF 117.9; CAA weather & radio; lights, field marks, beacon, Lincoln cht. Turf Runways: NW-SE 4700, NE-SW 3170. John H. Hanner & Jack Bender, Mgrs., Tel 48.

NEVADA

LAS VEGAS—McCarran Field. *ALAMO AIRWAYS:* Hangar, $2 nite; tie-dwn, $1 nite; *TEXACO* 80-90-100; line svce, A&E 24 hrs; major & minor, single & multi-eng, radio, airframe; minor instru; eng parts; wash, polish, clean. Dealer: *CESSNA.* Taxi, U-Drive cars; weather 24 hrs, tel. 4777; food on field 24 hrs; 23-unit motel on field; pilot lnge; all crdt crds. Airport: 6 mi S; el 2171; lat 36-10, long 116-10; no lndng fee; Mt. Whitney cht; tower, Unicom, lights, radio, ILS NE runway, beacon. Paved runways: 3, longest 6500. Robert Metten, Mgr., Tel 4866. Airlines: BAL, TWA, UAL, WAL.

NEW JERSEY

TETERBORO—Teterboro Airport. *ATLANTIC AVIATION:* 2 htd hangars; tie-dwn; *ESSO* 80-91-100; line svce continuous, A&E 8 hrs; major airframe, radio & instru, minor eng; wash, polish, clean. Dealer: *BEECH, CONTINENTAL, ARC, LEAR, NARCO, U.S. RUBBER.* Weather teletype. Pilot lnge, lodging, food 7 a.m.-Midnite. Food to go: 1 hr. notice required, delivered to aircraft. *HERTZ,* taxi, car, limousine. 1 & 2 eng chtr svce. Airport: Cmrcl, NY sect cht, 30 min to NY, 24-hr svce. El 5, lat 40-51, long 74-03, radio tower, lights, ILS, beacon. Paved runways: N 4500, NE 4500. Obstr: Trees SW, bldg NE. No lndng fee. Wm. Beveridge, Mgr., Tel Hasbrouck Heights 8-1775. Airlines: Cargo only.

TRENTON—Mercer County Airport (W. Trenton). *SPARTAN AIRCRAFT CO:* Navy type hangar, nominal fees. No chrge tie-dwn; *MOBILGAS* 80-91-100; line svce 8 to 5, later on request; A&E 8 to 5; major all types single & multi-eng, radio, instru, airframe; wash, polish, paint, int clean; prop overhaul shop; taxi, weather svce, food 7 to 7, lodging Trenton, pilot lnge with TV. Airport: County, 4 mi NW; el 200, lat 40-16, long 74-49; NY cht; no lndng fee; Unicom 222.8; Macadam runways: 4, longest 4000; Obstr: Marked. John D. Stephen, Mgr., Tel 6-3329.

NEW YORK

ELMIRA—Chemung County Airport. *ELMIRA AERONAUTICAL CORP:* Community, T hangars, per diem storage from $1.50; self-svce tie-dwn, no fee; *MOBILGAS* 80-91-98-100; line svce 24 hrs, A&E 8 a.m.-5 p.m. local time; major & minor single-eng, minor multi-eng; major & minor airframe. Dealer: *PIPER.* Parts: *LYCOMING, CONTINENTAL, FRANKLIN.* Taxi, limousine. Weather (Insac), tel 9-2471. Food on field 7 to 7; lodging nearby. Pilot lnge. Airport: 3 mi Horseheads; el 950; lat 42-09, long 76-53; no lndng fee; tower, radio, lights on request, 24 hr oper; Albany cht, beacon, seg circle marking. Paved runways: 3, longest 4700. Obstr: Sur by hills, lighted. Glenn S. Banfield, Mgr., Tel 9-1371. Airlines: AAL, CAP, MOH.

NORTH CAROLINA

CHARLOTTE—Douglas Municipal Airport. *SOUTHERN FLIGHT SVCE:* Hangars, 2 steel, 1 wood; hangar fees, $2 to $5; tie-dwn limited. *ESSO* 80-91-100; line svce 6 a.m.-11 p.m.; A&E 8 a.m.-5 p.m. Major m'ntenance single & multi-eng, radio, air frame; instru exchange. Dealer: *CONTINENTAL, COLLINS, ARC, LEAR, NARCO, BENDIX, BEECH, GOODYEAR, GE, SCINTILLA, DuPONT.* Weather 24 hrs; food on field 6 a.m.-11 p.m.; lodging 1 mi; pilot lnge; *AVIS,* driver svce, auto chrtr. Airport: 6 mi SE; el 748, lat 35-13, long 85-56; no lndng fee; tower 24 hrs; low freq radio, ILS. Paved runways: 3, longest 7500. Beacon, lights, field mrkings. Obstr: Marked. Dave Rea, Mgr., Tel 3-7911. Airlines: CAP, EAL, PAI, SOU.

OHIO

YOUNGSTOWN—Youngstown Municipal Airport—*YOUNGSTOWN AIRWAYS:* 2, conc, steel; no tie-dwn fee; *STANDARD* 80-91-100; line svce, A&E; major single-eng, some multi-eng; major airframe, minor instru; eng parts; wash, polish, paint, clean. Dealer: *CONTINENTAL, LEAR, BEECH.* Taxi, limousine, *HERTZ.* Weather, tel. Warren 34501; food on field 6:30 a.m.—11:30 p.m.; lodging Y'gstown, Warren, Sharon; pilot lnge. Airport: 10 mi N; el 1196; lat 41-15, long 80-40; lndng fee, scheds only; radio, tower, ILS, VOR; 24 hr oper; Cleveland cht; field, rnwy marks, beacon. Paved runways: 4, longest 7500. Obstr: Trees. S. K. G. Granger, Mgr., Tel 82181. Airlines: CAP, LCA, UAL.

SOUTH CAROLINA

CHARLESTON—Charleston Municipal Airport. *HAWTHORNE FLYING SVCE:* 1 wood hangar, storage; no chrge tie-dwn; *ESSO* 80-91-100; line svce & A&E 24 hrs; major single & multi-eng, airframe, radio; replace instru new or exchange; *CONTINENTAL, LYCOMING, FRANKLIN* parts & major overhaul; wash, polish, paint, int clean. Dealer: *CONTINENTAL, LYCOMING, FRANKLIN, P&W, LEAR, NARCO, BEECH, PIPER, GOODYEAR* (tires & brakes), *SENSENICH, READING* (batteries), *CHAMPION, RANDOLPH* (paints). Limousine, taxi, *HERTZ.* Weather, tel 4-3207; food on field 6 a.m.-8 p.m.; lodging, Charleston; pilot lnge. Airport: Mun, 11 mi N; el 42, lat 32-45, long 80-04; no lndng fee; Savannah sect cht; tower, beacon lights; oper 24 hrs. Paved runways: E, NW, NE, all 7000. Obstr: Water twr. G. Marion Reid, Jr., Mgr., Tel 4-3644. Airlines: DAL, EAL, NAL.

SKYWAYS FLIGHT OPERATIONS ROUND TABLE

Skyways Round Table

(Continued from page 57)

characteristics are going to be developed, and that's through actual service experience. We also feel that operators such as Mr. Barnes and Mr. Eastburn are in a position to do an economically efficient job of such service testing. I'd say even more so than the military. We heartily endorse that approach."

Donald B. Talmage: "I have one comment on the type of aircraft to be used, I don't think a lot can be gained with the types that are currently available, and I don't think a test operation should be set up until you have a multi-engine ship. A lot of the operational difficulties that you'll get into with a single-engine ship can be thrown out the window when you get multi-engine rotary-wing aircraft."

Harry Pack: "That's looking at it strictly from the standpoint of the airline operator gaining the total value, but I'm looking at it from the standpoint of the military, the manufacturer and the airline being able to jointly progress more rapidly through what we might call an airline or scheduled type of efficiency which should be carried out in such an operation."

Glidden S. Doman: "Before we close this meeting, I'd like to explain that Mr. Waldo's theme was exactly what I had in mind. I have a feeling that the trend toward divergence in the regulations is a great one. It's a battle today though AIA committees do try to keep those regulations together. I've also heard a lot of interest expressed by the military in what the commercial operators want in the form of a specification. My original thought was to endorse what this committee is doing and to state my belief that the military has a hope of getting enough commercial ships which do match their specs to help get their budget down."

Leslie O. Barnes: "I'd like to support Mr. Pack's statement that the best way to develop good and reliable specifications for the helicopter we're talking about for commercial operations, whether it be a 20-passenger machine or a 30, is to service test in actual operation. Such a service operation would have to be industry supported and perhaps be done in combination with a military project. It would be something that benefits all the industry and not just the carrier involved.

"I think that that is one of the most important points that have been brought up."

Warren T. Rockwell *(Hiller Helicopters).* "We've been going around and around on the difference between the 40-place helicopter, the 20-place, and on up and down the line. We have under development a heavy-duty flying truck type helicopter for the Army which will probably be ready for commercial use within the next 10 years. That helicopter will meet some of the requirements of Allegheny Airlines, some of the requirements of N.Y. Airways, and some of the requirements, we hope of the heavy-lift movements in Canada."

anley Hiller, Jr. *(Pres., Hiller Helicopters)*: It is still too early in the art of helicopter esigning to accurately reach any final deci-on or concrete forecast of the future trend f development. However, it is agreed that ree major steps lie ahead of us which will t as the foundation for future designs.

"The first step in a trend toward the ulti-ate design will doubtless be found in con-entionally powered, improved medium-sized elicopters with twin engines, one or two ain rotors, and carrying 12 to 14 passengers. s a result of development programs now in ork for the military, there should next ap-ear lower cost, tip-powered, one or two-pas-nger helicopters. Finally, we should see rge-sized, utility crane-type helicopters in dvanced tip-powered configurations. The itial acceptance of such machines will even-ally lead toward civilian fields of duties.

"For all of these reasons, we should not mit our thinking in size of present-design oncepts for commercial use, but should con-ition the public mind, in gradual steps, to cept the future tip-powered 40-passenger y busses and cargo vehicles as normal rowth of the American helicopter industry.

Summary

ed M. Glass: *"Gentlemen, I think we have l concluded that numerous commercial uses the helicopter are visualized and that de-ed characteristics of the machine itself vary ith the specific use contemplated.*

"As a 'replacement for the DC-3' the local-rvice carriers desire a multi-engine machine ith single-engine performance capable of rrying 40 passengers at a speed of 150 mph r distances up to 250 miles without refuel-g. Direct operating cost for such machine ould not exceed 3 cents per available pas-nger/mile.

"Carriers operating in very short haul traf-c-congested areas, such as New York Air-ays between New York airports, basically ant a machine of these same general charac-ristics but are not quite as demanding as to perating costs, cruising speeds or size—indi-ting that a 20-place helicopter operating at 0 mph and with direct costs in excess of 3 nts per available seat/mile, would be satis-ctory for most routes.

"Contract operations such as conducted by kanagan will want a single-engine machine, pable of carrying a 1200-pound payload.

"The manufacturers indicate the availabil-y in the not too distant future—but subject military requirements—of helicopters of e general operational configurations above scribed, but all manufacturers indicate a luctance to predict the commercial cost.

"Turbine engines for short-range operations e generally looked upon with favor as pow-plants for these larger machines, and noise ppression is recognized as a 'must' in order r the helicopter to be accepted in highly ngested areas. Necessity for these larger achines being initially designed to meet ilitary specifications is generally accepted.

"And that, gentlemen, brings us to the close our meeting. May I join SKYWAYS in anking you for your participation."

Jet Transport Outlook

(Continued from page 11)

With these new ships England hopes to retain and further develop the world market it has captured and expects to expand between now and the time the American jets become available. In this respect England has not done badly, what with *Comet* orders from Canadian Pacific, Quantas, Air France, Japan Airlines and others, and with the Vickers-Armstrongs turboprop *Viscount* having been sold to a number of non-English airlines. Most observers would agree that this sales trend will continue for a few years at least.

Two more new English jet transports may also be available. These are a commercial version of the A. V. Roe Company Delta-wing bomber and a commercial version of the Handley Page Crescent-wing bomber. However, it seems too soon to be certain that these additional competitive opportunities—or threats, if you like—will become realities.

The technical pioneering represented by the *Comet* and *Viscount* designs and operations is commendable and noteworthy. While Aeronautica may finally record the *Comet* as preceding the art somewhat, it will surely do so in a congratulatory tone. These English accomplishments could not have come easy. For example, the *Comet* was not the "overnight wonder" as often intimated. First specification activity was undertaken in March, 1943 and now, 10 years later, about 18 aircraft have been delivered for airline use. The jet-powered *Comet*, the Vickers-Armstrongs turboprop-powered *Viscount*, and the Bristol turboprop-powered *Britannia* have all been developed as a matter of British national policy with considerable support by state money.

With respect to the military, England's heavy jet-bomber program is just now materializing. The A. V. Roe four-jet Delta-wing bomber prototype first flew last August after a relatively rapid prototype development program. The Handley four-jet Crescent-wing bomber flew early this year. These aircraft will not be seen in sizeable quantities soon.

The contrast between the current status of English and U. S. large jet military programs is strikingly in favor of the U. S. For example, six-jet long-range Boeing B-47's were being produced at a rate of about one airplane per working day from one facility nearly a year ago. Today, these aircraft are being produced at three separate facilities. The Consolidated B-60, eight-engine jet bomber, was built and flown in only eight months. While many B-32 parts were used, this is nevertheless an impressive accomplishment. The Boeing eight-jet B-52 is now being perfected after a most impressive development program. The U. S. aircraft industry need

(Continued on page 64)

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Jet Transport Outlook

(Continued from page 59)

make no apologies when compared to the British aircraft industry insofar as military aircraft design and production are concerned. However, the U. S. aircraft industry is presently behind the British in the development of commercial jet transports if the number of aircraft produced to date as criteria.

Much has been said about "slow" English production. This production situation seems to be improving, particularly in the case of the Vickers-Armstrongs *Viscount*. While it is difficult to conceive of any really basic reason why English production rates should be less than those obtainable in the U. S., situations are evident which militate against and retard the accomplishment of high completion rates. These are: a general shortage of factory facilities, shortage of workers and workers' homes at the desired locations, shortage of materials for factory and home construction, reluctance of English workmen as a class to change location or to work on night shifts, general acceptance of England's relatively low level of economy and seeming inability to substitute high-production techniques for the traditional British concept of individual craftsmanship. The last point does England well for prototype development but not for high production. The English factories seem well arranged and equipped with ample equipment, including machine tools. Because of military commitments Vickers-Armstrongs, which has only recently achieved a filled-in *Viscount* production line, will soon move its entire *Viscount* production activity to another site some miles away. DeHavilland has arranged for the production of *Comets* at three widely separated facilities. While this type of diversion does not make for immediate improvement, the English production rate is bound to improve eventually, particularly under pressure of government-assigned high priorities. However, with the vast resources that could likely be made available here, it would be only a question of time, when an appropriate airplane design and orders exist, until the total numbers of jet-transport aircraft produced in this country would equal total English output.

The possibility of converting heavy jet bomber-type aircraft into commercial transports is not very attractive, even assuming it would be practical for the military to release aircraft for such purposes. This is due to important and justifiable differences in operational requirements which would necessitate redevelopment and redesign so extensive as to warrant spending the engineering manpower on new airplane designs.

Therefore, it appears that the most practical way the U. S. manufacturers can successfully compete against the British in the jet-transport world market is by developing new advanced jet transports which will most economically serve the commercial market. Economy of operation must be considered a prime requirement—the jet must compete favorably with existing transports in terms of rate structure in order to one day become the backbone of our fleet operations, not only with respect to outstanding safety and performance but also to justify quantity operations. Economy of the jet transport is influenced primarily by engine operating characteristics. Lack of engines capable of reliable economical commercial use is probably the principal reason U. S. manufacturers have not previously actively undertaken jet-transport developments. It is no doubt a fair statement to say that the newer high-powered American jet engines have the minimum power and the maximum tolerable fuel-consumption characteristics for economical jet-transport operation. In two or three years these engines should have a sufficient testing and experience background to warrant commercial use.

If the U. S. manufacturers will proceed in earnest soon, say during 1953, prototype jet aircraft could be developed and flying in 1956 and aircraft could be in limited production by 1957 or 1958. This is virtually contemporary with the new British designs which are intended to be fully competitive. However, the practical exigencies of shakedown, Federal certification, proving flights and quantity airplane deliveries will militate somewhat against realizing sizeable fleet operations with U. S. jets—or with the new British jets for that matter—before 1959 or 1960.

Jet Transport

A jet transport in the process of development in the United States could carry 33,000 passengers a year between Europe and America. Two such planes could carry 27,000 more passengers than does the HMS Queen Mary.

Three U. S. Manufacturers have declared their interest in and have spent considerable money in the study and preliminary development of commercial jet transports. The Boeing Airplane Company announced plans last year to proceed with the design and development of a jet transport. The Douglas Airplane Company is very actively studying all aspects of the design problem and an announcement of its intentions is expected momentarily. Lockheed Aircraft is also actively turning out jet-airplane design studies. With this intense activity and with suitable engines on the immediate horizon, one could easily conclude that at least one and probably more than one commercial jet-transport type soon will be in active design status in this country.

Since new-type British jet transports must be developed to reasonably compete with forth-coming American jets, both with respect to performance and economy, and since both countries will have new-type jet aircraft available at about the same time, it appears that if the design excellence of the American jets can equal those the British can produce, the present time-lead that the British enjoy will be materially lessened in the next several years. Considering the favorable U. S. margin of production facilities, it will all but disappear by early 1960.

With respect to the incorporation of operational experience with the *Comets* and *Viscounts* into succeeding designs, the British do have a definite advantage. But offsetting this to some extent will be the lessons learned from the vast U. S. military operations with long-range, high-flying jet aircraft. While summary numbers on operational flight hours to date are unavailable, the experience already accumulated must be large and will no doubt grow at a very impressive rate. Military experience will make toward improved mechanical reliability. However, this experience will not necessarily answer the many questions that will arise out of committing a large number of transports for operations on U. S. airways and in compliance with air traffic control procedures. In this respect, plenty of prior planning and fresh thinking will be advisable and necessary if we are to gain the most that the jet will offer.

The advantage of British jet-transport experience can be further offset if the U. S. manufacturers will incorporate into the detail design of their jets, knowledge resulting from the vast wealth of operating experience of the U. S. airlines. These accumulated operations are vastly greater than those of all the rest of the world put together, and with careful attention to successful detail design and operational necessities, real gains can be had. Ordinarily, it requires more effort to arrive at a satisfactory simple design than it does to arrive at what we too frequently encounter—marginally satisfactory or unsatisfactory complex designs. Experience should be the final judge between the acceptable and the unacceptable detail design and, in many instances, this experience is already available and needs only to be directly applied throughout all development phases. Manufacturers that are completely thorough and conscientious in the application of this principle to their designs will find extra dividends in a favorable market response to their products.

Basic research continues at a high rate of productivity in both the U. S. and England. It is difficult to find any marked over-all superiority between these two efforts, at least on the basis of observation and review of available data on this subject. However, one would be inclined to assume that in the long run we will lead due to the tremendous research facilities that are becoming available here. While research is an indispensable and uncompromising prerequisite to true advancement in aircraft design precepts and design follow-through, the accurate value of designs can be determined only through their application. While the British lead in the numbers of commercial jets produced to date, the numbers of both military and commercial jets produced in England are considerably less than the numbers of military jets produced to date in U. S. This large U. S. experience being ploughed back daily into succeeding designs, coupled with continuing advancements in research certainly does not indicate technical inferiority in this country but instead would tend to support the view that we actually lead considering the over-all effort, both civil and military.